A COMPLETE

TREATISE

ON

PRACTICAL

LAND-SURVEYING,

In Seven Parts:

Designed chiefly for the

USE OF SCHOOLS AND PRIVATE STUDENTS.

BY A. NESBIT,

Land-Surveyor, Master of the Classical, Commercial, and Mathematical Academy, Oxford-Street, Manchester; and Author of "A Treatise on Practical Mensuration," "A Treatise on Practical Gauging," "Keys to the Mensuration, and Gauging," "An Introduction to English Parsing, adapted to Murray's Grammar," and "A Treatise on Practical Arithmetic," &c &c.

THE FIFTH EDITION,

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TO THE

REV. FRANCIS WRANGHAM, M.A. F.R.S.

Archdeacon of the East Riding of Yorkshire,
Examining Chaplain to the Archbishop of York, &c. &c.

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TO WHOM

THE AUTHOR OF THIS WORK IS UNDER THE
GREATEST OBLIGATION,

THIS EFFORT

TO RENDER A MOST VALUABLE SCIENCE FAMILIAR
TO THE MEANEST CAPACITY;

IS

HUMBLY AND RESPECTFULLY INSCRIBED,

BY HIS MUCH OBLIGED

AND MOST OBEDIENT SERVANT,

A. NESBIT.

Entered at Stationers' Hall.

INTRODUCTION.

The various works which so imperfect a being as man is able to perform, and the great advances which he is capable of making in the arts and sciences, are astonishing. He comes into the world devoid both of strength and of reflection; nor are the powers of his body more rapidly developed, than those of his mind. But however ingenious and active the individual may prove, when arrived at maturity, his efforts would generally be unavailing, if they were not combined with those of his fellows. His first improvements he acquires from the suggestions of his contemporaries, or from the works of his predecessors, whose rules and demonstrations have been the labour of ages.

From the Old Testament, it appears, that the arts and sciences were cultivated to a certain extent, before the flood. Among the offspring of Cain, Jubal was the father of all such as handled the harp and organ; and Tubal-Cain was the instructor of every artificer in brass and iron. According to Josephus, the posterity of Seth also observed the order of the heavens, and the course of the stars.* The same author asserts, that the Assyrians and Chaldeans were the first, after the deluge, who applied themselves to the cultivation of the sciences. Their king, Belus, is said to have converted the tower of Babel into an observatory, and upon it to have made many astronomical discoveries.

With regard to the origin of Land-Surveying, historians vary in their opinions. Diodorus, Herodotus, and Strabo, attribute the invention of it to the Egyptians; whom they represent as constrained by the annual inundation of the Nile, removing or defacing their land-marks, to devise some method of ascertaining the ancient boundaries after the waters had retired. By Josephus, however, it is ascribed to the Hebrews. According to him, the arts and sciences of Egypt were derived from the patriarch Abraham, who conveyed them into that country, from Ur of the Chaldees.

The science in question was originally called 'Geometry;' but this being deemed too comprehensive a title for the mensuration of superficies, it was afterwards denominated 'The Art of Measuring Land.'

From the banks of the Nile, it was carried into Greece by Thales, one of the seven wise men, born before Christ 640 years. This philosopher travelled into Egypt, and studied, under its sages, astronomy, geometry, and other branches of the mathematics; but having given offence to king Amasis, by the freedom of his remarks upon the conduct of princes, he returned home, and employed himself in communicating the knowledge which he had acquired.

The great utility of Land-Surveying, without which it is impossible to conduct the affairs of civilized life, induced many of the most celebrated philosophers and mathematicians of antiquity to study its principles; and to Thales, Pythagoras, Socrates, Plato, Aristotle, Euclid, Archimedes, &c. we are indebted for many substantial improvements. The ancient Romans, likewise, it is said, held this art in such high veneration, that they accounted no man capable of commanding a legion, who was incapable of measuring a field.

The increasing value of land, and the consequent necessity of ascertaining its dimensions and content with accuracy, have lately called forth many Treatises on this subject; the principal of which we owe to Dix, Davis, Talbot, Crocker, and Cotes; but as these Works take a very limited view of the subject, and are, in my opinion, very deficient in *practical* information, and consequently not well adapted either for Schools or private Learners, I have been induced to write the following Work, which, I hope, will be found to contain every necessary instruction both on *theoretical* and *practical* Surveying.

I have carefully studied the Works of my predecessors and contemporaries; selected from them such matter as I thought most useful; and combined it with the information that I have received from some of the first Land-Surveyors in the kingdom, and with my own *practical* experience for upwards of twenty-five years.

The Work thus compiled and composed, I have divided into Seven Parts, upon each of which I shall make a few observations.

PART THE FIRST contains such Definitions, Problems, and Theorems in Geometry, as I conceived to be indispensably necessary in Land-Surveying. Those who desire to see the subject more fully treated, are referred to the Elements of Simpson, Emerson, Bonnycastle, Keith, Playfair, and Leslie; to Simson's Euclid, Hutton's Course of Mathematics, and Reynard's Geometria Legitima. The last Work is well adapted to the capacities of Youth; and contains a number of *Quæstiones Solvendæ*, at the end of each Book; to which an excellent Key has lately been published by the Author.

PART THE SECOND contains a description of the Chain, Cross-Staff, Offset-Staff, Compass, and Field-Book; also directions and cautions to young Surveyors, when in the field; and a few observations relating to Scales, laying down Figures, &c. &c.

The description of the Compass, together with an account of the variation of the Needle, has been given, under the convic-

[illegible] that the exact range of some line ought always to be taken, in the field, in order to determine the true situation of the estate.

Part the Third treats of the method of surveying with the Chain and Cross; and of measuring Meres, Woods, and Lines upon which there are Impediments.

I am aware that Professional Surveyors seldom or never use a Cross; but I am of opinion that every Learner should be taught the use of this instrument, in order to make him acquainted with the method of forming a right-angle in the field; and to give him a just idea of the nature and properties of the base and perpendicular of a triangle.

In this Part I have exhibited the absurdity of the processes frequently adopted by unskilful Surveyors, in computing the contents of Narrow Pieces of Land, and of Offsets. Methods leading to such erroneous results, ought to be discarded by every one who is ambitious of obtaining the appellation of a correct Surveyor.

I have also introduced the method of computing the contents of Narrow Pieces of Land, and of Offsets, by means of Equidistant Ordinates, which will be found more easy, expeditious, and accurate, than finding their areas by a succession of triangles and trapezoids.

No previous Writer with whom I am acquainted, has given this method in such a manner as to make it applicable to general practice; but the Rules which I have laid down may be applied with success in all cases when the fences are not *very* irregular, without first measuring the base, in order to divide it into an even number of equal parts, which is a general rule given by all former Writers on this subject.

Part the Fourth treats of the method of surveying with the Chain only; and of measuring Meres, Woods, Roads, Rivers, Canals, Distances, Lines upon which there are Impediments, and Hilly Ground.

The method of measuring Proof-Lines, in surveying single fields, which I have not observed in any preceding publication, forms a portion of the subject of this Part. Before I discovered this method, I frequently incurred the disagreeable necessity of repeating my survey, when disputes took place concerning the measurement. In large surveys, however, I am aware, it has long been known and practised by Professional Surveyors.

In this Part, likewise, I have treated largely upon the surveying of Hilly Ground, which seems to have been hitherto little regarded, and still less understood by the generality of Writers on Land-Surveying; and, to the method of preserving the horizontal line by elevating the chain, I have subjoined the description and use of King's Quadrant, as well as the mechanism and application of one of my own invention. I have also added a few directions for finding the hypothenusal measure of Hilly Ground, for paring, reaping, &c.; but this generally depends upon dividing it into proper figures.

This subject is closed with a Remark on the impropriety and injustice of returning the hypothenusal measure of Hills, *universally*; although it has been long and strenuously contended for, by *Theoretical* and *Superficial* Writers. This Remark, together with the following Observation, which I have *since* met with, in Professor Leslie's Geometry, second edition, page 401, will, I think, tend to set this subject completely at rest: "In surveying Hilly Grounds, it is not the absolute Surface that is measured, but the diminished quantity which would result, had the whole been reduced to a horizontal plane. This distinction is founded on the obvious principle, that since plants shoot up *vertically*, the vegetable produce of a swelling eminence can never exceed what would have grown from its *levelled* base. All the sloping or *hypothenusal* distances are, therefore, reduced *invariably* to their *horizontal* lengths, before the calculation is begun." Thus we see the *opinion* and *practice* of Professional Surveyors approved and supported by one of the most profound Mathematicians and Philosophers in the United Kingdom.

PART THE FIFTH contains four of the most approved methods of surveying large Estates or Lordships; general and particular Rules for planning them; and copious Directions for finding their Contents.

The use of the Parallel Ruler, in straightening crooked fences, is also given, in twelve entirely new Problems, comprising every possible case that can occur in Practice. Several methods of copying and reducing Plans have likewise been introduced, particularly the description and use of the Pentagraph, which instrument far surpasses any other, for that purpose.

Three different methods of embellishing Plans are given, containing directions for shading and colouring Meadows, Pastures, Corn-fields, Moors, Marshy Grounds, Sands, Rocks, Trees, Lakes, Rivers, Sea-Shores, Hills, Pleasure-Grounds, Gardens, and the Bases and Elevations of Buildings.

This Part also contains directions for making Compartments; Observations on Penmanship; and a Plan of a New Town, laid out in such a manner as to form straight streets, at right-angles with each other, which is by far the most eligible method of laying out Building-Ground. An Architectural Elevation of a House is likewise given, in order to shew the young Surveyor how to proceed, if he should be requested to give a view of the buildings belonging to an Estate.

This Part is illustrated by no fewer than nine copper-plates, fourteen wood-cuts, and a neatly engraven Field-Book; and it may not be improper to state, that the Estates contained in Plates Eight and Ten, are *actual* Surveys, taken by the Author.

Part the Sixth contains Rules and Directions for Laying-out, Parting-off, and Dividing Land; illustrated by a greater number of examples than I have met with in any other Treatise. If any of them should appear superfluous to experienced Surveyors, they will please to recollect for whom the Work is designed.

In parting-off, and dividing land, by means of guess-lines, as a difficult branch of the art, I have been particularly explicit; and have exemplified the method by numerous examples, illustrated by figures exhibiting the various lines used in each process.

The method of dividing a Common among various Proprietors, according to the different qualities of the Land, has also been introduced; and copious directions have been given for valuing land, and conducting an Inclosure. I have likewise inserted an Abstract of the General Inclosure Act, which will be found to throw more light on the subject of Inclosures, than was ever before given to the Public, in any Treatise on Surveying.

Indeed, the only Work that takes any notice of Inclosures, is one published by Mr. Stephenson, (price sixteen shillings,) in which the Author appears to have treated the subject with considerable ability. This Work, however, is not at all adapted either for Schools or private Learners, as the first principles of Land-Surveying are not clearly elucidated.

As various customary measures prevail in different Counties, I have given General and Particular Rules for reducing them to statute-measure; and *vice versâ.* I have also introduced Scotch and Irish Land Measure; by which the Work becomes adapted to every part of the United Kingdom.

Part the Seventh contains the method of measuring and planning Villages, Towns, and Cities; directions for surveying and planning Building-Ground, and dividing it into convenient lots for Sale; and Miscellaneous Questions relating to surveying, laying-out, parting-off, and dividing Land in general.

Nothing has been said on the method of measuring, planning, and laying-out Building-Ground, by any former Writer; but as it is a subject of great public importance, in the vicinity of large and improving towns, it ought by no means to be omitted in a Treatise on Land-Surveying.

The Miscellaneous Questions at the end of this Part, will serve to exercise the genius of the Learner, after he has acquired a competent knowledge of the principles of surveying and dividing Land, by carefully studying the former part of this Work. Such Questions tend to rouse the latent energies of youth; and to give them a relish for making interesting calculations; and a delight in discovering unknown truths. They also call into action those abilities which might otherwise lie dormant, for want of objects of sufficient importance to excite the curiosity of the ingenious; and put the powers of their minds into motion.

As the Theodolite is sometimes used in surveying Meres, Woods, Roads, Rivers, and Canals, when angles cannot be taken by the Chain, I have given a description of that instrument; but as neither it nor the Plane Table are ever used by Professional Surveyors, when they can avoid it; and as this Treatise is confined chiefly to Chain Surveying, I have not given any directions for measuring either with the Plane Table or the Theodolite. Besides, the expence of these instruments places them out of the reach of a great number of those persons who may be desirous of learning Surveying; and as most estates may be measured more correctly by the Chain only; the method of surveying by these instruments would only have tended to enhance the price of this Work, without adding much to its real utility.

Levelling is a subject in which Writers on Surveying generally *dabble;* but nothing that I have yet seen, deserves the name of a Treatise on Levelling. The only examples worthy of notice, are a few in Jones's Treatise on Mathematical Instruments, selected from the Works of Le Febvre.

In preparing this Work for the Press, I felt a strong inclination to comply with the request of my Friends, by saying something on the subject of Levelling; but on mature consideration, I found that the number of copper-plates, and the quantity of letter-press necessary to do justice to the subject, would have too much increased the price of the present Work. However, if health and life should permit, I may, perhaps, at some future time, turn my attention to this *desideratum.*

Having given a brief description of the contents of the following Work; it is only necessary to add, that I have endeavoured to treat the whole, to the best of my abilities, not only in a *theoretical,* but also in a *practical* manner. The greater part of the Examples for single fields, have been taken from my own Field-Books; consequently, they are such as the Learner will generally meet with in taking actual Surveys. Hence, in going through this Work, he will become familiar with the method of keeping the Field-Book; so that when he commences Field Practice, he will find no embarrassment in entering his Notes.

Copious directions have been given, in various parts of the Work, for taking the dimensions of all kinds of figures that can possibly be met with in the practice of Surveying. This is of the greatest importance in measuring; for it is evident that if the dimensions be improperly taken, the results must, of course, be incorrect; notwithstanding the greatest care may be taken in laying down the figures, and finding their contents.

The engraven Field-Book, being detached from the Surveying, will also be found extremely convenient in laying down the large Surveys; as it will, probably, be necessary for Learners to refer to the lines and stations upon the rough plans.

In composing the following Work, I have endeavoured to consult the wants of the Learner, in every possible way; consequently, no information that I conceived to be necessary, has been withheld. In order, however, to make a complete Surveyor, the Rules and Directions which I have laid down, must be brought into actual use by Field Practice; not only in measuring single Fields, but also in surveying large Estates; in laying-out, parting-off, and dividing Land, and in performing every process that occurs in *practical* operations.

Being daily employed in the education of Youth, I have had many opportunities of observing the numerous difficulties which Tutors have to surmount; it is, therefore, my highest ambition, that the following Work may be found well adapted for the use of Schools; and be a means of rendering a most useful and delightful science familiar to the rising generation. Such as it is, I respectfully commit it to the world; trusting that slight mistakes will be pardoned, that serious ones have not been incurred, and that the forbearance which I have exercised towards the labours of others, will be exercised towards mine in return.

A. NESBIT

MANCHESTER, Feb. 1833.

P. S. It may, perhaps, be proper to inform the young reader, that Professor Leslie, whose opinion I have quoted, in the former part of this Preface, concerning the method of measuring Hilly Ground, was late Professor of Mathematics, and is now Professor of Natural Philosophy, in the University of Edinburgh; and has given to the world several valuable Works, which rank him with the first Mathematicians and Philosophers of the Age.

MR. NESBIT receives into his House a limited number of BOARDERS, for the purpose of Tuition. The Terms of the School and other particulars may be known, by applying to MR. NESBIT, Oxford Street, Manchester.

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TO THE SECOND EDITION.

The flattering Testimonies which the Author has received, not only from many of the first Teachers and Mathematicians in the kingdom, but also from a considerable number of Professional Surveyors and Commissioners, concerning the merits of the First Edition of this Work, have induced him to revise the whole; and make every Addition and Improvement that he thought would render the Second Edition still more acceptable to his Friends and the Public.

Accordingly, it will be found that this Edition is enriched with the addition of five new copper-plates; forty wood-cuts; one hundred and ten new questions: and exceeds the former Edition by one hundred and forty pages. And as a much smaller type has been chosen, both for the text and the notes, the Work, in its present form, contains *nearly* twice as much matter.

The Improvements thus introduced, are dispersed through the whole of the Work; but it may be proper to observe, that the method of computing by Equidistant Ordinates; and of measuring and planning Roads, Rivers, and Canals, did not appear in the former Edition; and that Part the Fifth has been re-written; and four of the most approved methods of surveying large Estates, described; and also illustrated by copper-plates.

The use of the Parallel Ruler, in straightening crooked fences, has likewise been given, in twelve new Problems, comprising every case that can possibly occur in Practice.

The description of the Pentagraph, and its use in copying and reducing Plans, have also been added; together with three different methods of making and ornamenting finished Plans.

Much new and valuable Information has been adduced on the method of conducting Inclosures, valuing land, &c. &c.; and an Abstract of the General Inclosure Act inserted, which will tend greatly to elucidate the subject.

Scotch and Irish Customary-Measures have likewise been given; and also the method of measuring by the Gad; and of making an estimation of the number of acres contained in a Common, County, or Kingdom.

Part the Seventh, describing the method of surveying and planning Villages, Towns, and Cities; and of measuring, planning, and laying-out Building-Ground, is entirely new; and will, the Author is persuaded, be found of essential service to Learners.

The Miscellaneous Questions, at the end of this Part, on surveying, parting-off, and dividing Land, may also be mentioned among the Additions and Improvements.

Bradford, Yorkshire, July, 1820. A. NESBIT

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The Engraven Field-Book to be stitched by itself.

EXPLANATION OF THE PRINCIPAL
MATHEMATICAL CHARACTERS.

The sign or character $=$ (called *equality*) denotes that the respective quantities, between which it is placed, are equal; as 4, poles $= 22$ yards $= 1$ chain $= 100$ links.

The sign $+$ (called *plus*, or more) signifies that the numbers, between which it is placed, are to be added together; as $9 + 6$ (read 9 *plus* 6) $= 15$. Geometrical lines are generally represented by capital letters; then $AB + CD$, signifies that the line C D is to be added to the line A B.

The sign $-$ (called *minus*, or less) denotes that the quantity which it precedes, is to be subtracted; as $15 - 6$ (read 15 *minus* 6) $= 9$. In geometrical lines also, $AB - CD$, signifies that the line C D is to be subtracted from the line A B.

The sign $\times$ denotes that the numbers, between which it is placed, are to be multiplied together; as 5×3 (read 5 multiplied by 3) $= 15$.

The sign $\div$ signifies division; as $15 \div 3$ (read 15 divided by 3) $= 5$. Numbers placed like a vulgar fraction, also denote division; the upper number being the dividend, and the lower the divisor; as $\frac{15}{3} = 5$.

The signs $: \; :: \; :$ (called *proportionals*) denote proportionality; as $2 : 5 :: 6 : 15$, signifying that the number 2 bears the same proportion to 5, as 6 does to 15: or, in other words, as 2 is to 5, so is 6 to 15.

The sign $\overline{\qquad\qquad}$ (called *vinculum*) is used to connect several quantities together; as $\overline{9+3-6} \times 2 = \overline{12-6} \times 2 = 6 \times 2 = 12$.

The sign ^{2}, placed above a quantity, represents the square of that quantity; as $\overline{5+3}^2 = 8^2 = 8 \times 8 = 64$.

The sign ^{3}, placed above a quantity, denotes the cube of that quantity; as $\overline{9+3-8}^3 = \overline{12-8}^3 = 4^3 = 4 \times 4 \times 4 = 64$.

The sign $\sqrt{}$ or $\sqrt[2]{}$, placed before a quantity, denotes the square root of that quantity; as $\sqrt{9 \times 4} = \sqrt{36} = 6$.

The sign $\sqrt[3]{}$, placed before a quantity, represents the cube root of that quantity; as $\sqrt[3]{\overline{6 \times 4 \times 3} - 8} = \sqrt[3]{\overline{24 \times 3} - 8} = \sqrt[3]{72 - 8} = \sqrt[3]{64} = 4$.

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LAND-SURVEYING.

Part the First.

Definitions, Problems, and Theorems in Geometry, requisite in Land-Surveying.

GEOMETRY originally signified the art of measuring the earth, or any distance or dimensions upon, or within it; but it is now used for the science of quantity, extension, or magnitude, abstractedly considered.

Geometrical Definitions.

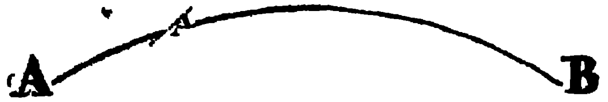
1. A point is considered as having neither length, breadth, nor thickness.

2. A line has length, but is considered as having neither breadth, nor thickness; as A B.

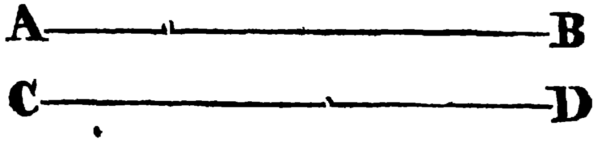
3. Lines are either right, curved, or parallel.

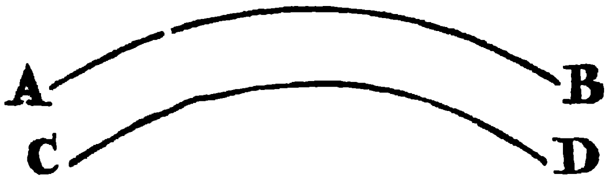
4. A right or straight line, lies wholly in the same direction, between its extremities; and is the shortest distance between two points; as A B.

5. A curved line continually changes its direction, between its extremities; as A B.

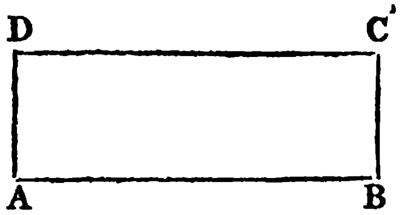


6. Parallel lines always remain at the same distance from each other, and though continually produced, would never meet; as A B, C D.





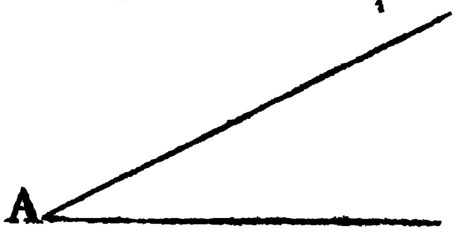
7. A surface or superficies, has length and breadth, but is considered as having no thickness; as A B C D.



8. A superficies may be contained within one curved line; but cannot be contained within fewer than three straight lines.

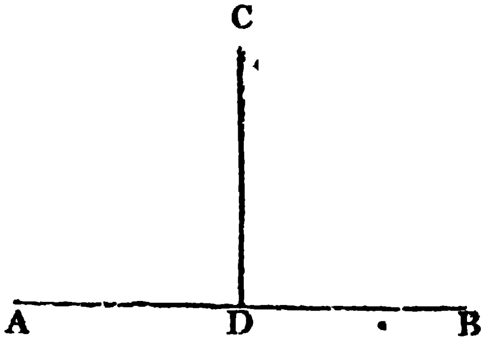
9. The area of a figure, is its superficial content, or the measurement of its surface.

10. An angle is the inclination or opening of two lines, having different directions, and meeting in a point; as at A, which is called the angular point; and, when three letters are used, the middle one denotes that point.

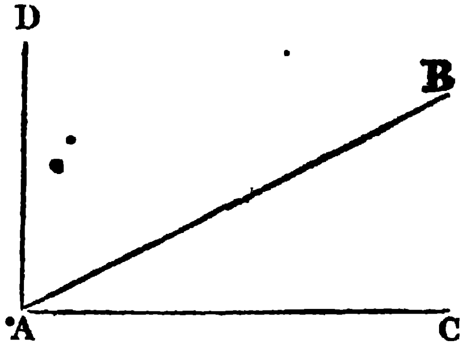


11. Angles are of three kinds; viz. right, acute, and obtuse.

12. A right angle is made by one right line standing perpendicularly upon another: thus, if D C be perpendicular to A B, the angles A D C and C D B are both right angles.

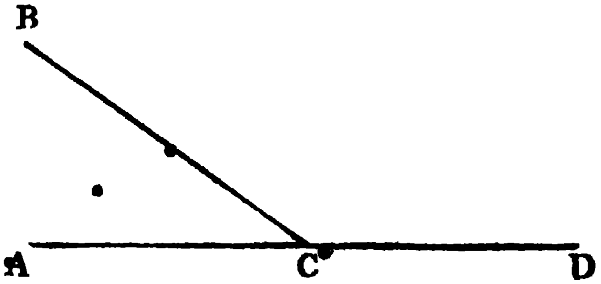


13. An acute angle is less than a right angle; as C A B.



14. The complement of an angle is what it wants to complete a right angle; as the angle D A B is the complement of the angle C A B.

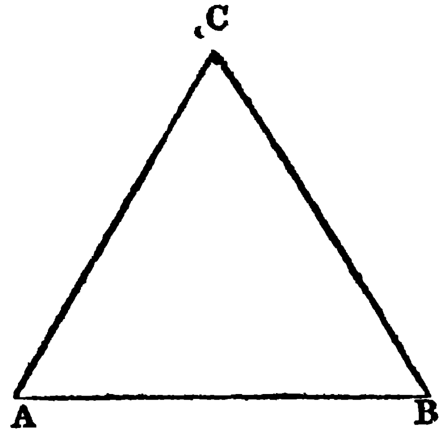
15. An obtuse angle is greater than a right angle; as B C D.



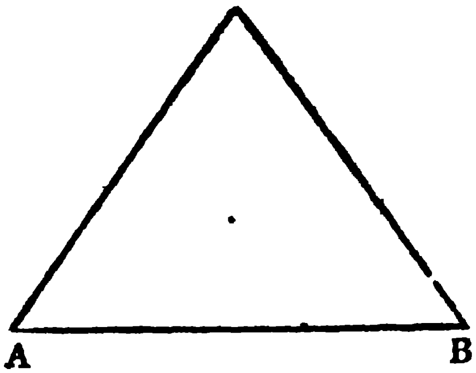
16. The supplement of an angle is what it wants of two right angles; as the angle A C B is the supplement of the angle B C D.

17. A triangle is a figure or superficies, bounded by three right lines, and admits of three varieties; viz. equilateral, isosceles, and scalene.

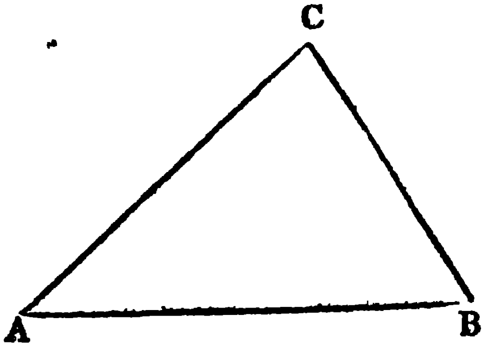
18. An equilateral triangle has all its sides equal; as A B C.



19. An isosceles triangle has only two of its sides equal; as A B C.

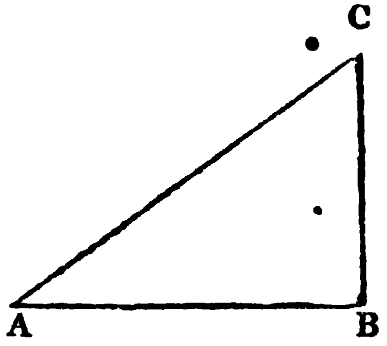


20. A scalene triangle has all its sides unequal; as A B C.

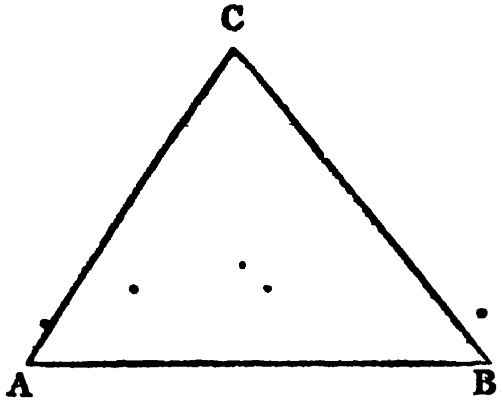


21. Triangles are also right-angled, acute-angled, and obtuse-angled.

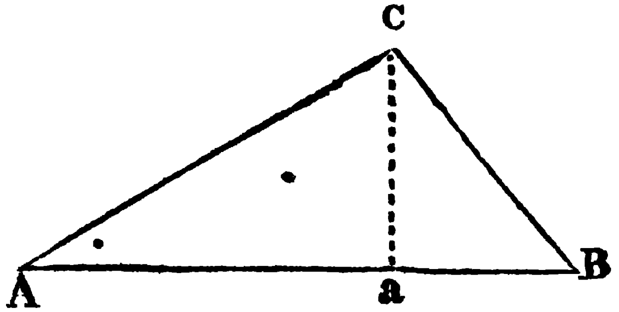
22. A right-angled triangle has one right angle, the side opposite to which is called the hypothenuse, the other two being termed legs, or one the perpendicular, and the other the base: thus, A C is the hypothenuse, B C the perpendicular, and A B the base.



23. An acute-angled triangle has all its angles acute; as A B C.



24. An obtuse-angled triangle has one obtuse angle; as A C B.

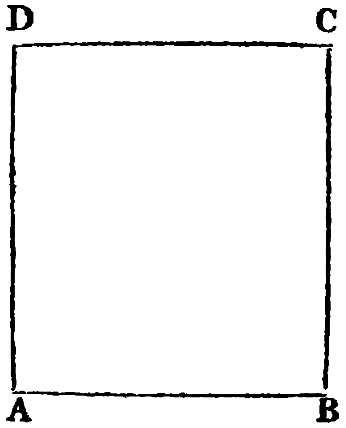


25. The longest side of any plane triangle is called the base; as A B; and a line falling upon it, from the opposite angle, at right angles, is called a perpendicular; as C a.

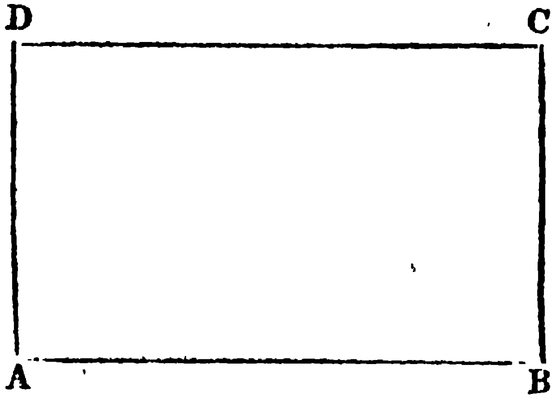
26. A figure of four sides and angles is denominated a quadrangle or quadrilateral figure.

27. A parallelogram is a quadrilateral figure, having its opposite sides parallel and equal; and admits of four varieties; viz. the square, the rectangle, the rhombus, and the rhomboid.

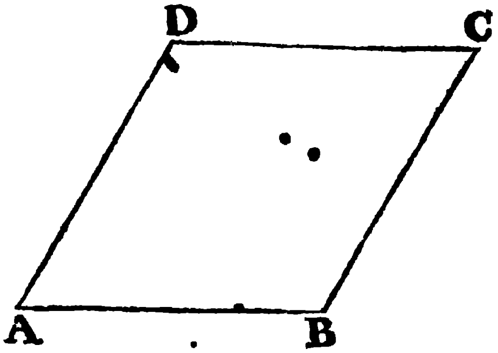
28. A square is an equilateral parallelogram, having all its angles right angles; as A B C D.



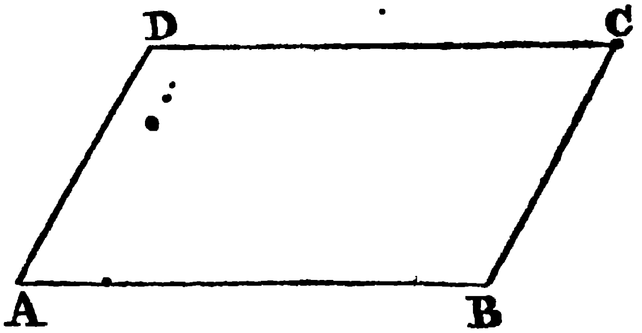
29. A rectangle is a parallelogram, having its opposite sides equal, and all its angles right angles; as A B C D.



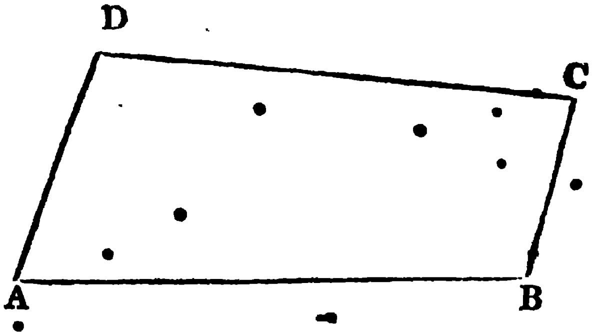
30. A rhombus is an equilateral parallelogram, having its opposite angles equal; as A B C D.



31. A rhomboid is a parallelogram, having its opposite sides and angles equal; as A B C D.

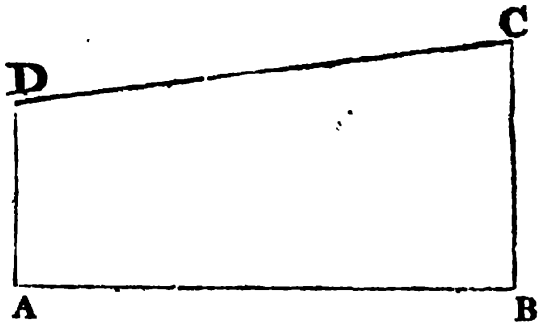


32. A trapezium is a quadrilateral figure, whose opposite sides are not parallel to each other; as A B C D.

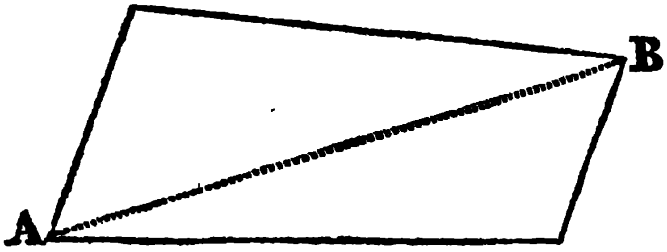


33. A trapezoid is a quadrilateral figure, having two of its opposite sides parallel, and one acute, one obtuse, and two right

angles; as A D, is parallel to B C; the angles at A and B, being right angles.



34. A diagonal is a right line, joining the two opposite angles of a quadrilateral figure, or irregular polygon; as A B.



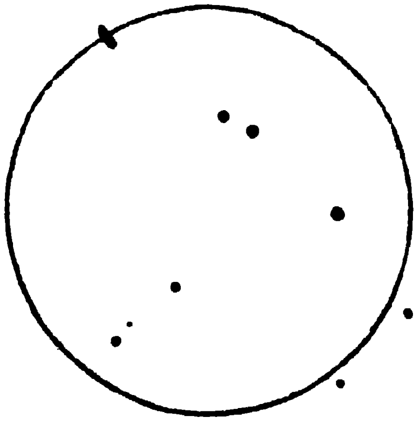
35. Plane figures, having more than four sides, are generally called polygons; and receive their particular denominations from the number of their sides or angles.

36. A pentagon is a polygon of five; a hexagon of six; a heptagon of seven; an octagon of eight; a nonagon of nine; a decagon of ten; an undecagon of eleven; and a duodecagon of twelve sides.

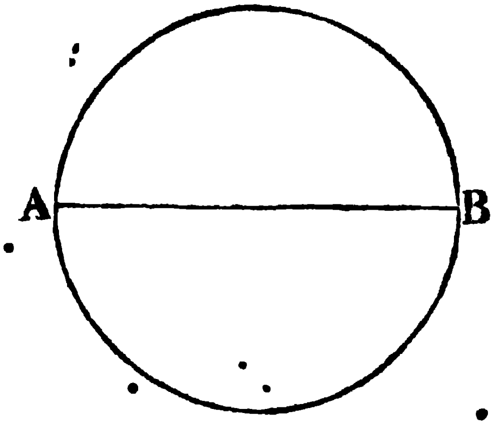
37. A regular polygon has all its sides and angles equal. When they are unequal, the polygon is irregular.

38. A circle is a plane figure, bounded by a curved line, called the circumference, which is every where equidistant from a certain point within it, called the centre.

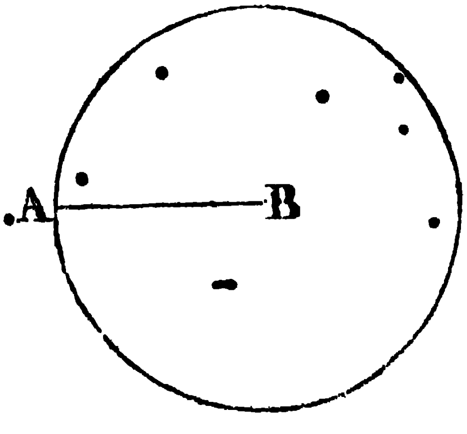
39. The circumference of every circle is supposed to be divided into 360 equal parts, called degrees; each degree into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds.



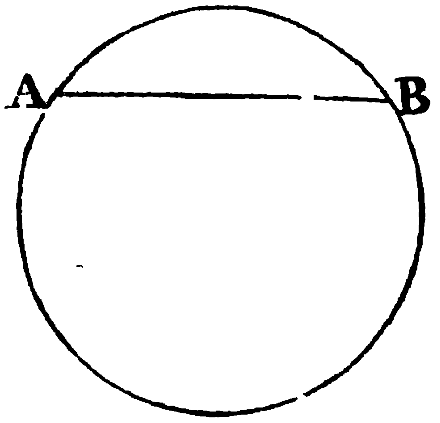
40. The diameter of a circle is a right line drawn through the centre, and terminating in the circumference on each side; as A B.



41. The radius of a circle is half the diameter, or it is a right line drawn from the centre to the circumference; as A B.



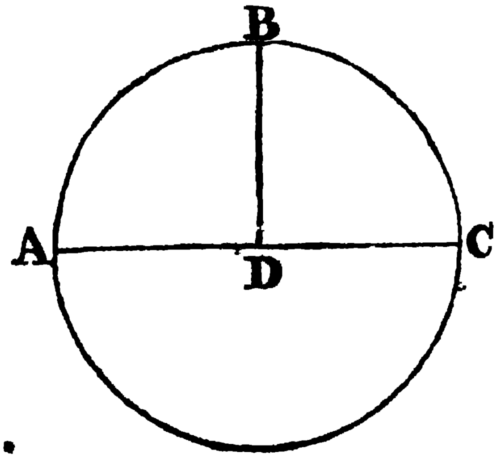
42. An arc of a circle is any part of the circumference; as the arc A B.



43. A chord is a right line joining the extremities of an arc; as the line A B.

44. A segment is any part of a circle bounded by an arc and its chord.

45. A semicircle is half of a circle, or a segment cut off by the diameter; as A B C.



46. A sector is any part of a circle bounded by an arc, and two radii.

47. A quadrant is the fourth part of a circle, or a sector bounded by an arc and two radii at right angles to each other; as C D B.

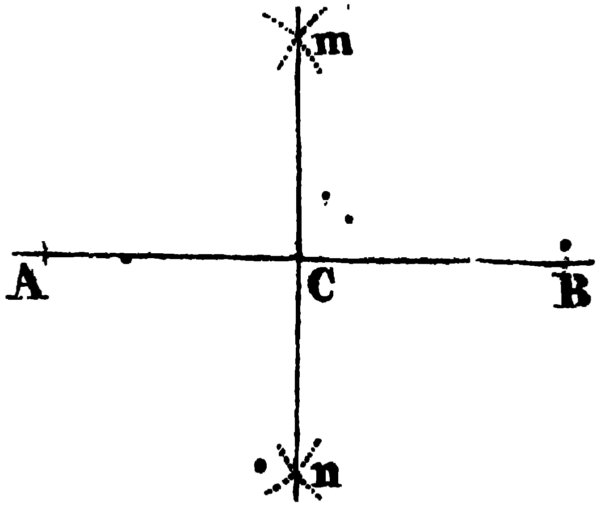
Corol. Hence a right angle is said to contain 90°.

Note.—All Definitions and Rules should be committed to memory.

GEOMETRICAL PROBLEMS.

PROBLEM I.

To bisect a given Line A B.

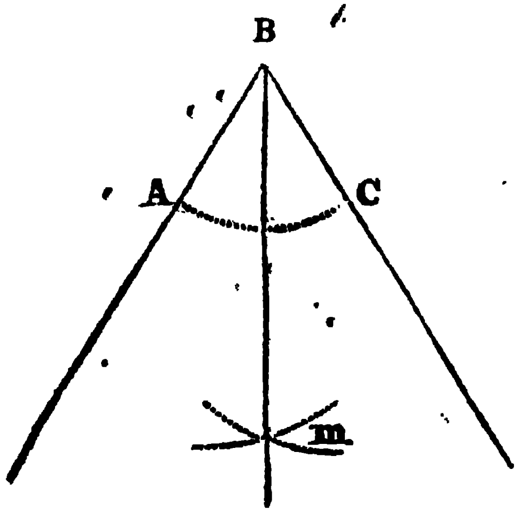


From A and B as centres, with any radius greater than half A B, in your compasses, describe arcs cutting each other in m and n.

Draw the line m C n, and it will bisect A B in C.

PROBLEM II.

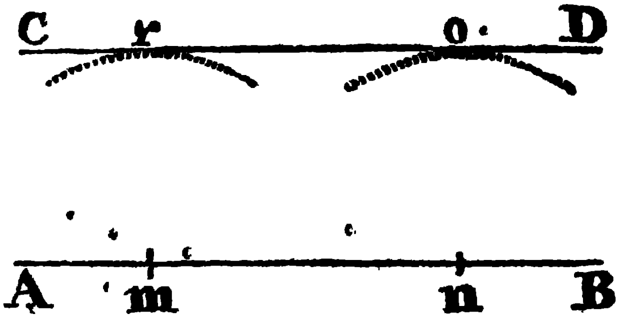
To bisect a given Angle A B C.



From the point B with any radius, describe the arc A C. From A and C with the same, or any other radius, make the intersection m. Draw the line B m, and it will bisect the angle A B C, as required.

PROBLEM III.

To draw a Line parallel to a given Line A B, *at a given Distance.*

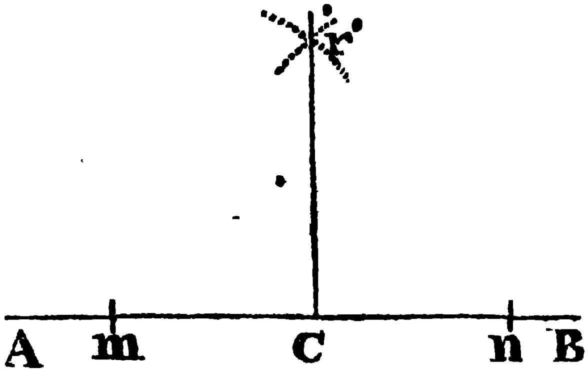


From any two points, m and n, in the given line, with the given distance as a radius, describe the arcs r and o. Draw C D to touch these arcs, without cutting them, and it will be parallel to A B.

Note.—This problem may be more readily performed by a parallel ruler.

PROBLEM IV.

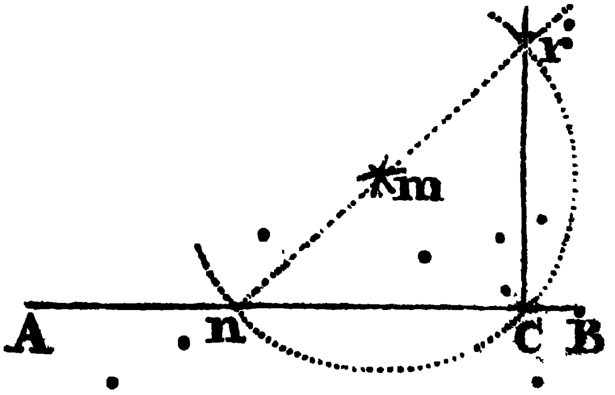
To erect a Perpendicular from a given Point C, *near the Middle of a given Line* A B.



On each side of the point C, take two equal distances, C m and C n; from m and n as centres, with any radius greater than C m or C n, describe two arcs cutting each other in r. Draw the line C r, and it will be the perpendicular required.

PROBLEM V.

To erect a Perpendicular from a given Point C, *near the End of a given Line* A B.

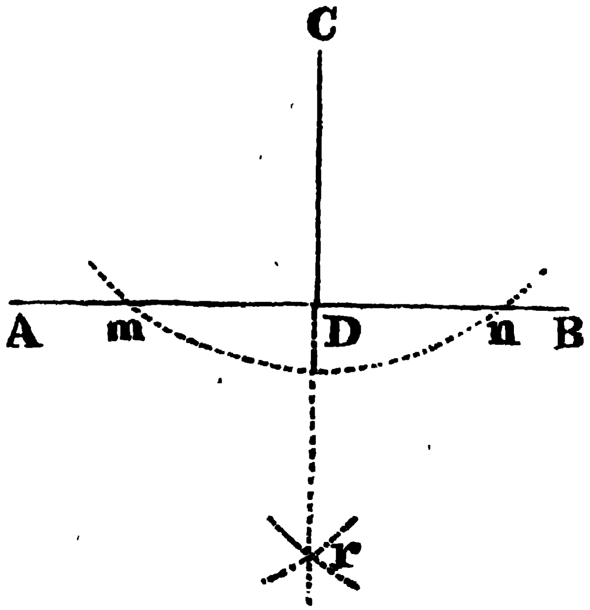


From any point m, as a centre, with the radius or distance C m, describe an arc cutting the given line in C and n.

Through n and m, draw a line cutting the arc in r. Draw the line C r, and it will be the perpendicular required.

PROBLEM VI.

From a given Point C, *to let fall a Perpendicular upon a given Line* A B.



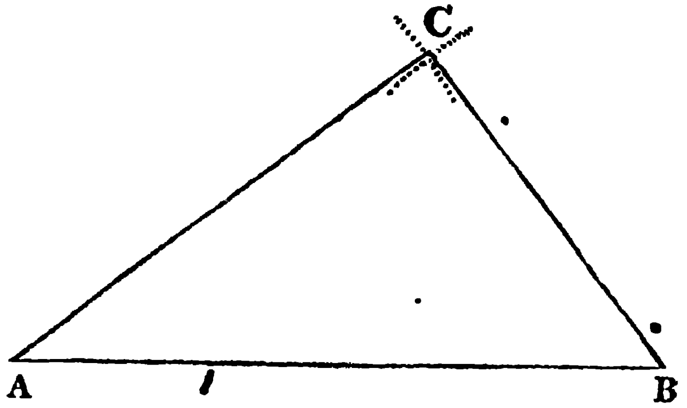
With C as a centre, and any radius, a little exceeding the distance of the given line, describe an arc cutting A B in m and n. With the centres m and n, and the same or any radius, exceeding half their distance, describe arcs intersecting each other in r.—Draw the line C r; and C D will be the perpendicular required.

Note.—The last three problems may be easily performed by a square, or a plotting scale.

PROBLEM VII.

To make a Triangle with three given Lines, any two of which must be greater than the third. (Euclid, I. 22.)

Let the given lines be A B=10, A C=8, and B C=6 chains.



From any scale of equal parts, (which is to be understood as employed likewise in all the following problems,) lay off the base A B.

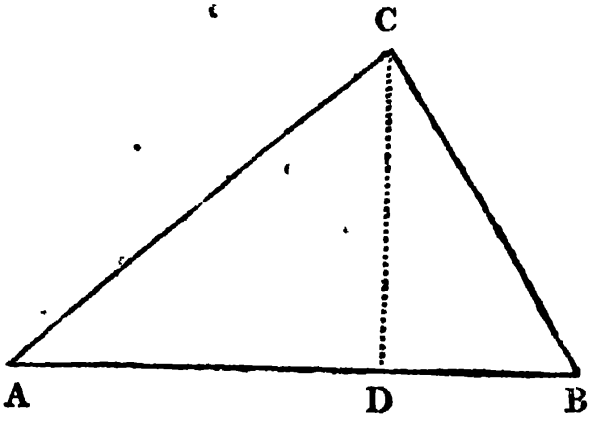
With the centre A, and radius A C, describe an arc. With the centre B, and radius B C, describe another arc, cutting the former in C. Draw the lines A C and B C, and the triangle will be completed.

Note.—Any trapezium may be constructed in the same manner; having the four sides, and one of the diagonals.

PROBLEM VIII.

Having given the Base, the Perpendicular, and the Place of the Perpendicular upon the Base, to construct a Triangle.

Let the base A B=9, the perpendicular C D=5, and the distance A D=6 chains.



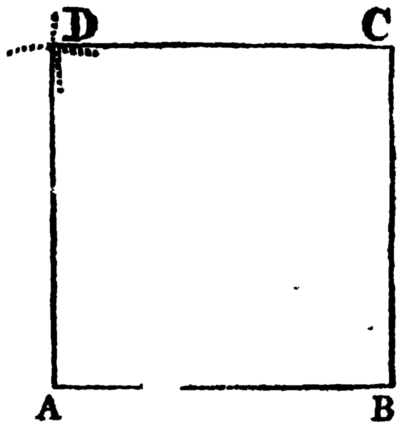
Make A B equal to 9, and A D equal to 6. At D erect the perpendicular D C, which make equal to 5. Join A C and B C, and the figure will be completed.

Note.—A trapezium may be constructed in a similar manner, by having one of the diagonals, the two perpendiculars let fall thereon from the opposite angles, and the places of these perpendiculars upon the diagonal.

PROBLEM IX.

To describe a Square, whose Side shall be equal to a given right Line.

Let the given line A B=4 chains.



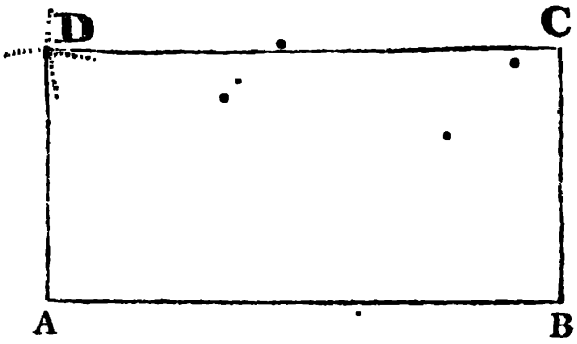
Upon one extremity B of the given line, by Problem V. erect the perpendicular B C, which make equal to A B.

With A and C as centres, and the radius A B, describe arcs cutting each other in D. Draw the lines A D and C D, and the square will be completed.

PROBLEM X.

To describe a rectangular Parallelogram, whose Length and Breadth shall be equal to two given Lines.

Let the length A B = 8, and the breadth B C = 4 chains.

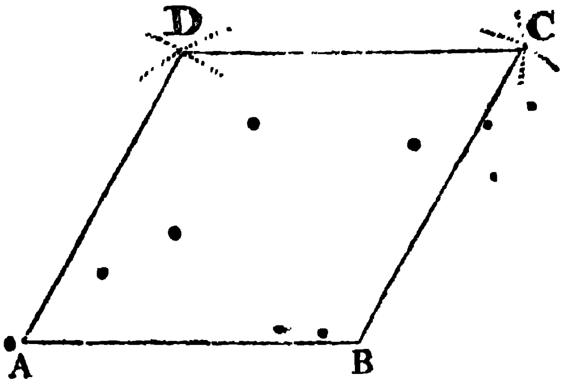


At B erect the perpendicular B C, which make equal to 4. With A as a centre, and the radius B C, describe an arc; and with C as a centre, and the radius A B, describe another arc, cutting the former in D. Draw the lines A D and C D, and the rectangle will be completed.

PROBLEM XI.

Upon a given right Line to construct a regular Rhombus.

Let the given line A B = 4 chains.



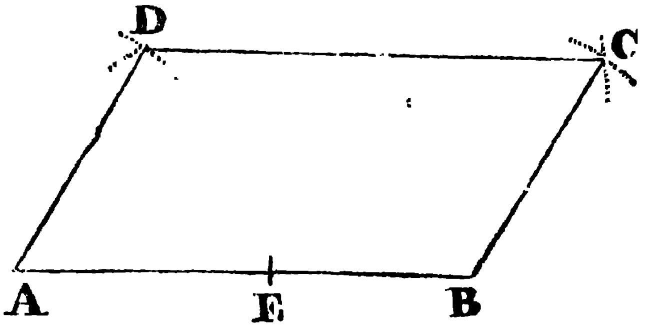
Draw the line A B, equal to 4. With A and B as centres, and the radius A B, describe arcs cutting each other in D; then with B and D as centres, and the same radius, make the intersection C.

Draw the lines A D, D C, and B C, and the rhombus will be completed.

PROBLEM XII.

Having any two right Lines given, to construct a Rhomboid.

Let the given lines be A B = 7, and B C = 4 chains.

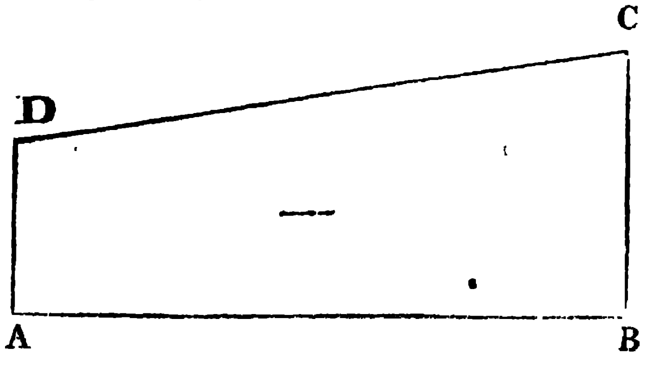


Draw the line A B, equal to 7. Take in your compasses the line B C, and lay it from A to E.—With A and E as centres, and the radius A E, make the intersection D. Then with B as a centre, and the same radius, describe an arc; and with D as a centre, and the radius A B, describe another arc, cutting the former in C. Draw the lines A D, D C, and B C, and the rhomboid will be completed.

PROBLEM XIII.

Having the Base and the two Perpendiculars given, to construct a Trapezoid.

Let the base A B=7, and the perpendiculars B C and A D=3 and 2 chains respectively.

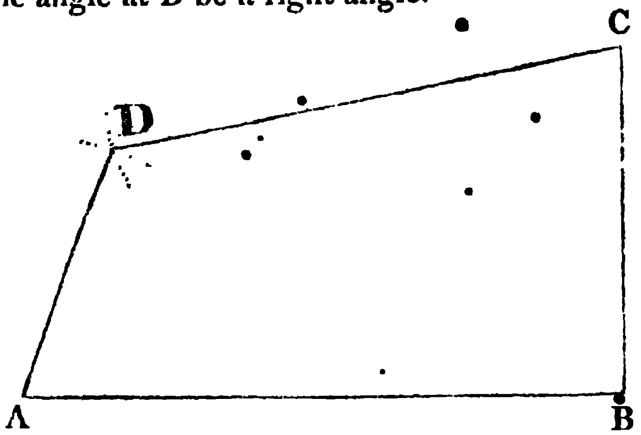


Draw the base A B, equal to 7, and erect the perpendiculars B C equal to 3, and A D equal to 2 chains. Then join D C, and the trapezoid will be completed.

PROBLEM XIV.

Having the four Sides given, to construct a quadrilateral Figure, which has one right Angle.

Let the sides A B=7, B C=4, C D=6, and D A=3 chains; and let the angle at B be a right angle.

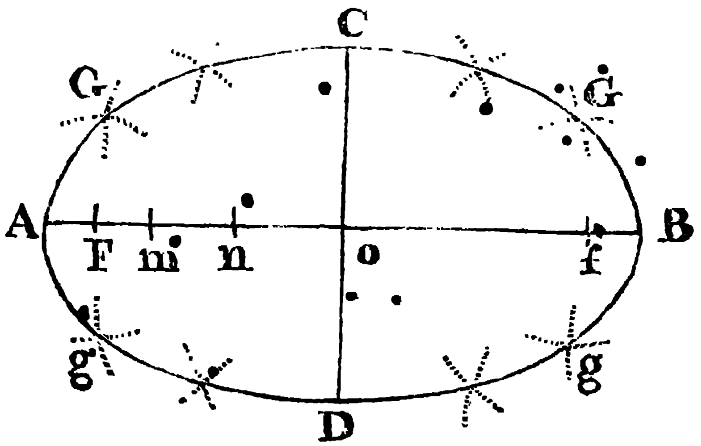


Draw the line A B, equal to 7; and erect the perpendicular B C, equal to 4 chains. With C as a centre, and the radius C D, describe an arc; and with A as a centre, and the radius D A, describe another arc, cutting the former in D. Draw the lines C D and D A, and the figure will be completed.

PROBLEM XV.

Having the transverse and conjugate Diameters given, to construct an Ellipsis.

Let the transverse diameter A B = 7, and the conjugate diameter C D = 4 chains.



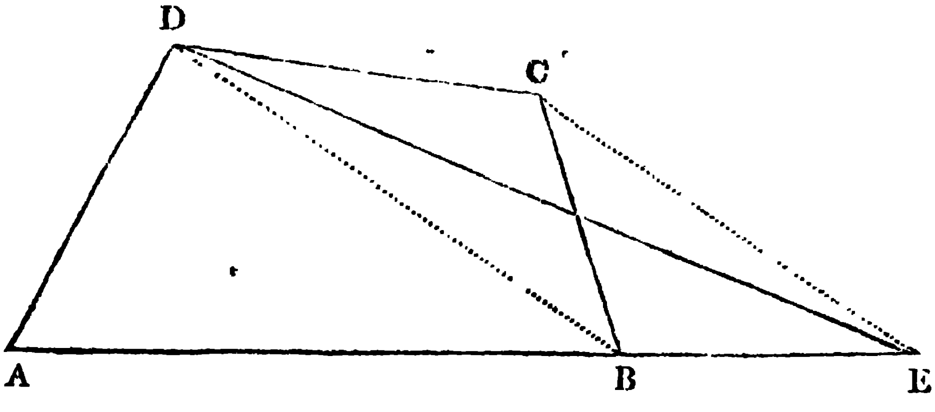
Draw the two diameters to bisect each other perpendicularly in the centre o. With the radius A o, and the centre C or D, intersect A B, in F and f.—These points will be the foci of the ellipse. Take any point m, in the transverse diameter, and with F and f as centres, and the radius A m, describe the arcs G, G, g, g. Then with the same centres, and the radius B m, describe arcs cutting the former in the points G, G, g, g: thus will you have four points in the circumference of the ellipse. After this, take a second point n, in the transverse diameter, and proceeding as before, you will determine other four points.—By the same method you may determine as many more as you please; through all of which, with a steady hand, you must draw the circumference of the ellipse.

Note.—An ellipse may also be constructed as follows: Having found the foci F, f, as before, take a thread equal in length to the transverse diameter A B, and fasten its ends, with two pins, in the points F, f; then stretch the thread to its greatest extent; and by moving a pencil round, within the thread, keeping it always tight, you will trace out the curve of the ellipse.

The principle upon which this construction is founded, may be seen in Prob. X. Part VI.

PROBLEM XVI.

To reduce a given Trapezium, A B C D, *to a Triangle of equal Area.*

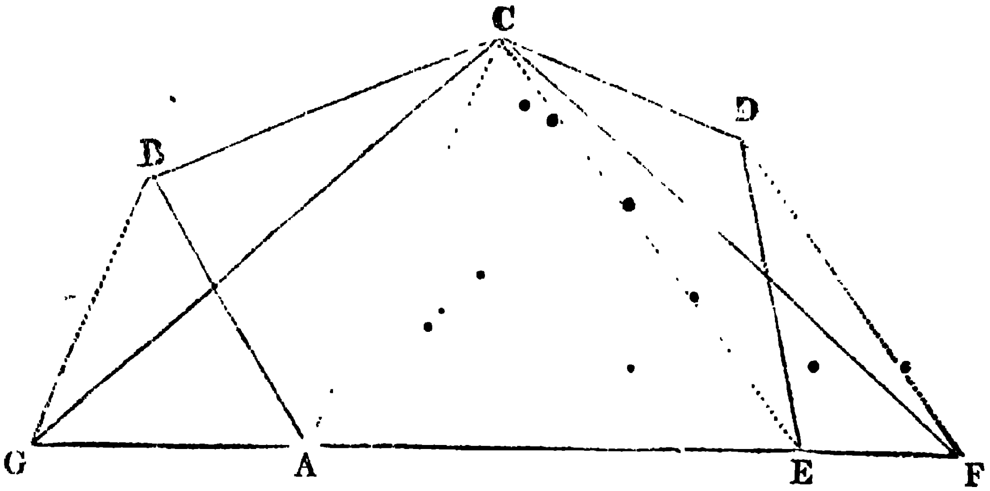


Draw the diagonal D B, and parallel to it draw C E, meeting A B produced in E. Join the points D E; so shall the triangle A D E be equal to the trapezium A B C D.

Note.—This and the following Problem may be applied in finding the areas of trapeziums and irregular polygons by first reducing them to triangles.

PROBLEM XVII.

To reduce an irregular Polygon A B C D E, *of five sides, to a Triangle of equal Area.*

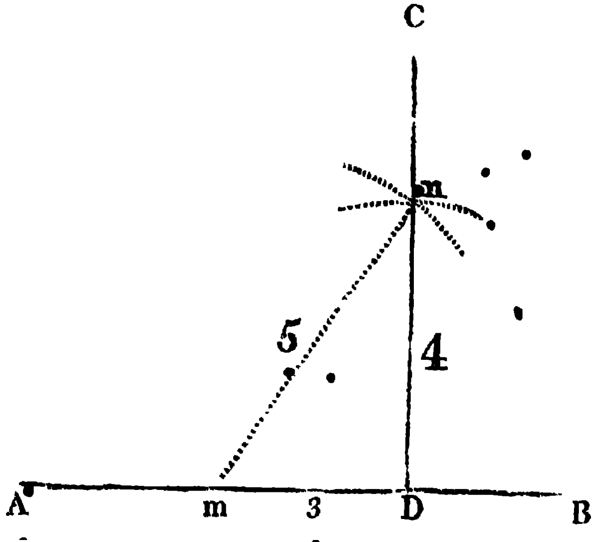


Extend the side A E, both ways at pleasure; and draw the diagonals C E, C A. Parallel to these diagonals draw the lines D F, and B G; join the points C F, C G; and G C F will be the triangle required.

Note.—Any irregular polygon of more than five sides, may be brought to a triangle of equal area, by reducing it successively to a figure with one side less, until you bring it to a figure of three sides. Thus the trapezium A B C F, or G C D E is equal to the polygon A B C D E, as well as the triangle G C F.

PROBLEM XVIII.

To raise a Perpendicular from any point D, *in a given Line* A B, *by a Scale of equal Parts.*

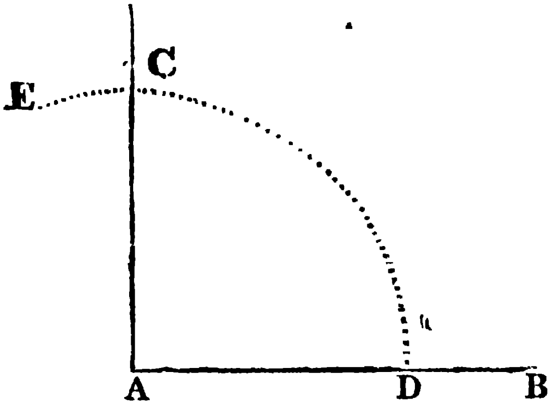


Make D m = 3; and from the points D and m, with the distances 4 and 5, describe arcs intersecting each other in n. From D, through the points n, draw the line D C, and it will be the perpendicular required.

Note.—This Problem may be performed by any other numbers in the ſame proportion; but 3, 4, and 5, are the least whole numbers that will make a right-angled triangle.

PROBLEM XIX.

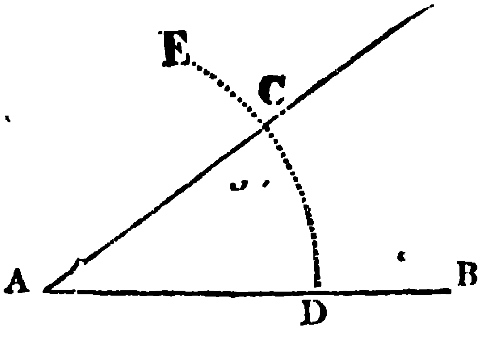
To make a right Angle by the Line of Chords on the plane Scale.



Draw the unlimited line A B; then take in your compasses 60° from the line of chords, and with A as a centre, describe the arc E D. Take 90° from the same scale, and set off that extent from D to C. Draw the line A C; and C A D will be the angle required.

PROBLEM XX.

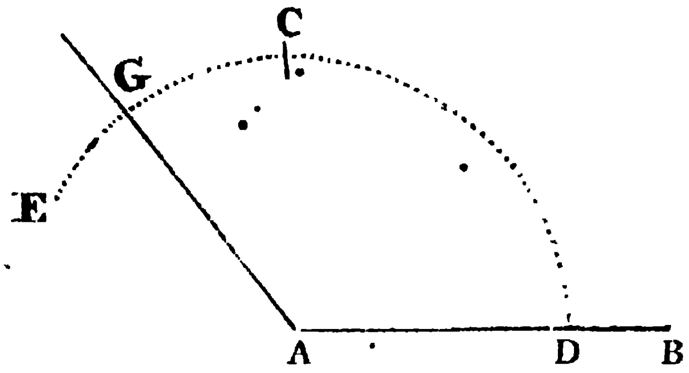
To make an acute Angle equal to any Number of Degrees; suppose 33° 30′.



Draw the unlimited line A B; then take 60° in your compasses, and with A as a centre, describe the arc E D. Then set off the angle, 33° 30′, from D to C. Draw the line A C; and C A D will be the angle required.

PROBLEM XXI.

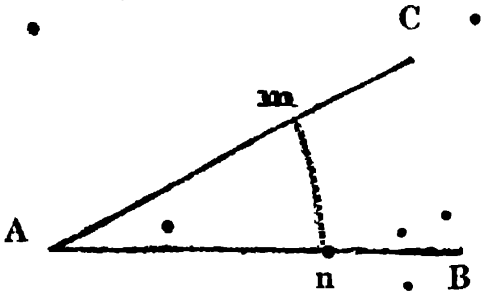
To make an obtuse Angle equal to any number of Degrees; suppose 125° 30′.



Draw the unlimited line A B; then take 60° in your compasses, and with A as a centre, describe the arc E D. Then set off 90° from D to C; and from C to G set off the excess above 90°, which is 35° 30′. Draw the line A G; and G A D will be the angle required.

PROBLEM XXII.

To find the Number of Degrees contained in any given Angle B A C.



With the chord of 60°, and A as a centre, describe the arc m n. Take the distance m n in your compasses, and apply it to the line of chords; and it will show the number of degrees required.

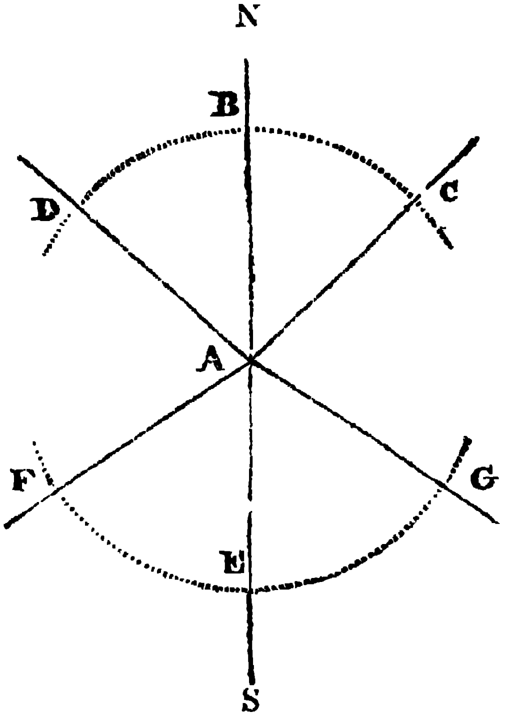
Note.—Angles may be more expeditiously laid down or measured by means of a semi-circle of brass called a Protractor, the arc of which is divided into 180 degrees.

PROBLEM XXIII.

To lay down a Line making a given Angle with the Meridian, or North and South Line.

EXAMPLES.

1. Let it be required to lay down a line that ranges N. E., making an angle of 45°, with the meridian line. *(See the Compass, Part II.)*



Draw the meridian line A N; and with the sweep of 60° in your compasses, taken from the line of chords, and A as a centre, describe the arc B C.

Set off the given angle 45°, from B to C; draw the line A C, and it will range N. E., as was required.

Note.—If the line had ranged N. W., the angle must have been set off on the other side of the meridian A N; and A D would have been the direction of the line.

2. Lay down a line that ranges S. W. b. W., making an angle of 56° 15′, with the meridian line.

Draw the meridian line A S; and with the sweep of 60° describe the arc E F.

Set off 56° 15′ from E to F; draw the line A F, and it will range S. W. b. W., as was required.

Note 1.—If the line had ranged S. E. b. E., the angle must have been set off from E to G; and A G would have been the direction of the line.

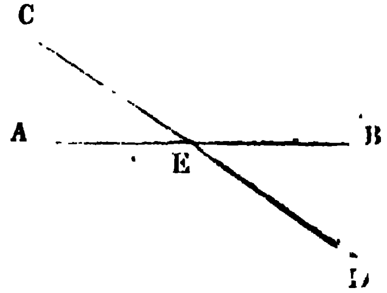
2.—This Problem will be found useful to young Surveyors, in laying down the first line, the range of which should be taken in the field by a compass.

GEOMETRICAL THEOREMS.

The Demonstrations of which may be seen in the Elements of Euclid, Simpson, and Emerson.

THEOREM I.

If two straight lines A B, C D, cut each other in the point E, the angle A E C will be equal to the angle D E B, and C E B to A E B. *(Euclid* I. 15. *Simpson* I. 3. *Emerson* I. 2.*)*

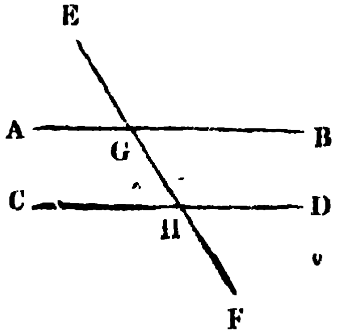


THEOREM II.

The greatest side of every triangle is opposite to the greatest angle. *(Euc.* I. 18. *Simp.* I. 13. *Em.* II. 4.*)*

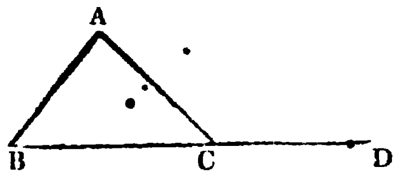
THEOREM III.

Let the right line E F fall upon the parallel right lines A B, C D; the alternate angles A G H, G H D are equal to each other; and the exterior angle E G B is equal to the interior and opposite, upon the same side G H D; and the two interior angles B G H, G H D, upon the same side, are together equal to two right angles. *(Euc.* I. 29. *Simp.* I. 7. *Em.* I. 4.*)*



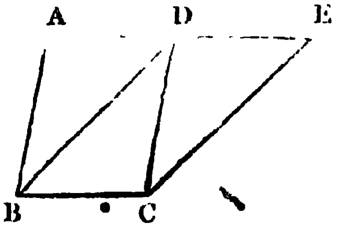
THEOREM IV.

Let A B C be a triangle, and let one of its sides B C be produced to D; the exterior angle A C D is equal to the two interior and opposite angles C A B, A B C; also the three interior angles of every triangle are together equal to two right angles. *(Euc.* I. 32. *Simp.* I. 9 *&* 10. *Em.* II. 1 *&* 2.*)*



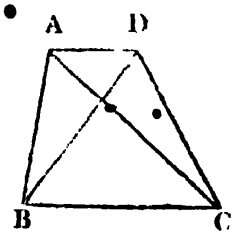
THEOREM V.

Let the parallelograms A B C D, D B C E be upon the same base B C, and between the same parallels A E, B C; the parallelogram A B C D is equal to the parallelogram D B C E. *(Euc.* I. 35. *Simp.* II. 2. *Em.* III. 6.*)*



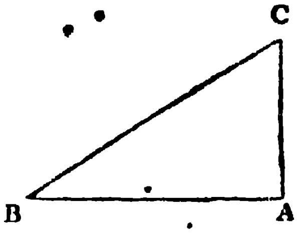
THEOREM VI.

Let the triangles A B C, D B C be upon the same base B C, and between the same parallels A D, B C; the triangle A B C is equal to the triangle D B C. *(Euc.* I. 37. *Simp.* II. 2. *Em.* II. 10.*)*



THEOREM VII.

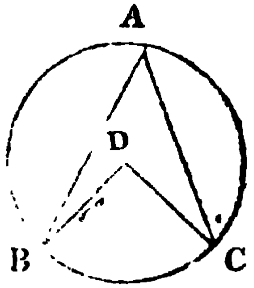
Let A B C be a right-angled triangle, having the right angle B A C; the square of the side B C is equal to the sum of the squares of the sides A B, A C. (Euc. I. 47. Simp. II. 8. Em. II. 21.)



Note.—Pythagoras, who was born about 2400 years ago, discovered this celebrated and useful Theorem; in consequence of which, it is said, he offered a hecatomb to the gods.

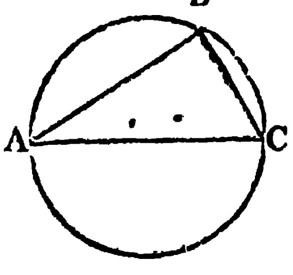
THEOREM VIII.

Let A B C be a circle, and B D C an angle of the centre, and B A C an angle at the circumference, which have the same arc B C for their base; the angle B D C is double of the angle B A C. (Euc. III. 20. Simp. III. 10. Em. IV. 12.)



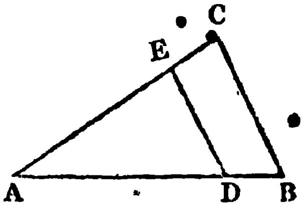
THEOREM IX.

Let A B C be a semi-circle; then the angle A B C in that semi-circle, is a right angle. (Euc. III. 31. Simp. III. 13. Em. VI. 14.)



THEOREM X.

Let D E be drawn parallel to B C, one of the sides of the triangle A B C; then B D is to D A, as C E to E A. (*Euc.* VI. 2. *Simp.* IV. 12. *Em.* II. 12.)

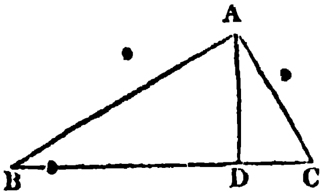


THEOREM XI.

In the preceding figure, D E being parallel to B C, the triangles A B C, A D E are equi-angular or similar; therefore A B is to B C, as A D to D E; and A B is to A C, as A D to A E. (*Euc.* VI. 4. *Simp.* IV. 12. *Em.* II. 13.)

THEOREM XII.

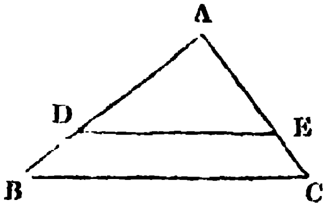
Let A B C be a right-angled triangle, having the right angle B A C; and from the point A let A D be drawn perpendicularly to the base B C; the triangles A B D, A D C are similar to the whole triangle A B C, and to each other. Also the perpendicular A D is a mean proportional between the segments of the base; and each of the sides is a mean proportional between the base and its segment adjacent to that side; therefore B D is to D A, as D A to D C; B C is to B A, as B A to B D; and B C is to C A, as C A to C D. (*Euc.* VI. 8. *Simp.* IV. 19. *Em.* VI. 17.)



THEOREM XIII.

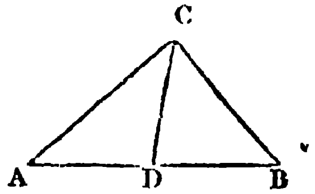
Let A B C, A D E be similar triangles, having the angle A common to both; then the triangle A B C is to the triangle

A D E, as the square of B C to the square of D E. That is similar triangles are to one another in the duplicate ratio of their homologous sides. (*Euc.* VI. 19. *Simp.* IV. 24. *Em.* II. 18.)



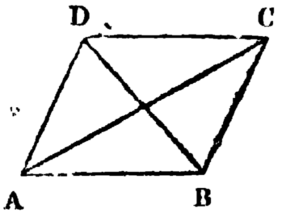
THEOREM XIV.

In any triangle A B C, double the square of a line C D, drawn from the vertex to the middle of the base A B, together with double the square of half the base A D or B D, is equal to the sum of the squares of the other sides A C, B C. (*Simp.* II. 11. *Em.* II. 28.)



THEOREM XV.

In any parallelogram A B C D, the sum of the squares of the two diagonals A C, B D, is equal to the sum of the squares of all the four sides of the parallelogram. (*Simp.* II. 12. *Em.* III. 9.)



THEOREM XVI.

All similar figures are in proportion to each other as the squares of their homologous sides. (*Simp.* IV. 26. *Em* III. 20.)

THEOREM XVII.

The circumferences of circles, and the arcs and chords of similar segments, are in proportion to each other, as the radii or diameters of the circles. (*Em.* IV. 8 & 9.)

THEOREM XVIII.

Circles are to each other as the squares of their radii, diameters, or circumferences. *(Em.* IV. *35.)*

THEOREM XIX.

Similar polygons described in circles, are to each other, as the circles in which they are inscribed; or as the squares of the diameters of those circles. *(Em.* IV. *36.)*

THEOREM XX.

All similar solids are to each other, as the cubes of their like dimensions. *(Em.* VI. *24.)*

LAND-SURVEYING.

Part the Second.

A Description of the Chain, Cross-Staff, Offset-Staff, Compass, and Field-Book; also Directions and Cautions to young Surveyors, when in the Field, &c.

THE CHAIN.

LAND is commonly measured with a Chain, invented by Mr. Gunter, which is known by the name of "Gunter's Chain."

It is 4 poles, 22 yards, or 66 feet in length, and divided into 100 equal parts, called links; each link being 7.92 inches. At every tenth link from each end, is fixed a piece of brass, with notches or points; that at 10 links having one notch or point; at 20, two; at 30, three; and at 40, four points. At 50, or the middle, is a large, round, plain piece of brass.

The chain being thus marked, the links may be easily counted from either end; the mark at 90, 80, &c. being the same as that at 10, 20, &c. Part of the first link, at each end, is made into a large ring or bow, for the ease of holding it in the hand.

The chain should always exceed 22 yards, by an inch and half, or two inches; because, in surveying, it is almost impossible to go in a direct line, or to keep the chain perfectly stretched. Long arrows likewise keep the ends of the chain a considerable distance from the ground; the lines, consequently, will be made longer than they are in reality.

Chains, when new, are seldom a proper length; they ought always, therefore, to be examined; as should those, likewise, which are stretched by frequent use.

Note 1.—In folding up the chain, it is most expeditious to begin at the middle, and fold it up double. When you wish to unfold it, take both the handles in your left-hand, and the other part of the chain in your right; then throw it from you, taking care to keep hold of the handles. You must then adjust the links before you proceed to measure.

2.—Chains, which have three rings between each link, are much better than those which have only two; as they are not so apt to twist.

THE CROSS-STAFF.

The Cross-Staff is an instrument used in the field by surveyors, to erect perpendiculars, and may very easily be made in the following manner.

Procure a piece of board about 6 inches square, either of sycamore, box, or mahogany.

Draw the two diagonals; and at their extremities fix four small studs or pins, which will serve as sights to direct to any object or angle.

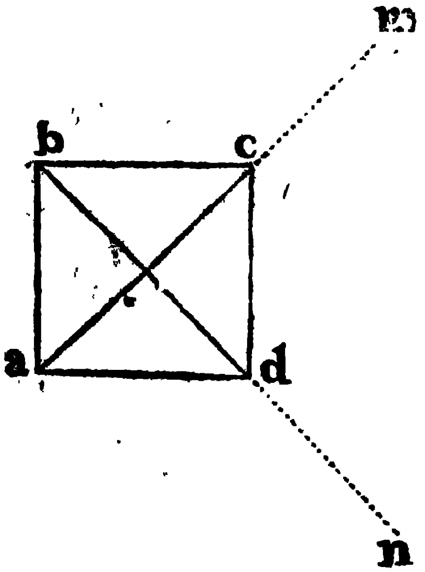
Or, instead of studs or pins, you may saw two fine grooves at right-angles, about a quarter of an inch deep, in the board.

This being fixed upon a staff, of a convenient length for use, pointed with iron at the bottom to enter the ground readily, the instrument is called a cross-staff.

Note 1.—The cross must be fixed upon the staff by a screw, in such a manner that it may be easily turned without moving the staff.

2.—The cross may be made of a circular piece of board; you must then draw two diameters crossing each other at right-angles. The fourth part of a square, or of a circle, will answer the purpose equally well.

3.—Great care ought to be taken in making this instrument, as its accuracy depends on the sights, or grooves being at right-angles with each other.



Suppose a b c d, to represent a cross, and the groove a c to be directed to an object at m; then, will the groove b d point to another at n.

Reverse the direction of the grooves, so that b d may be in the direction of m; then, if a c be in the direction of n, the instrument is correct.

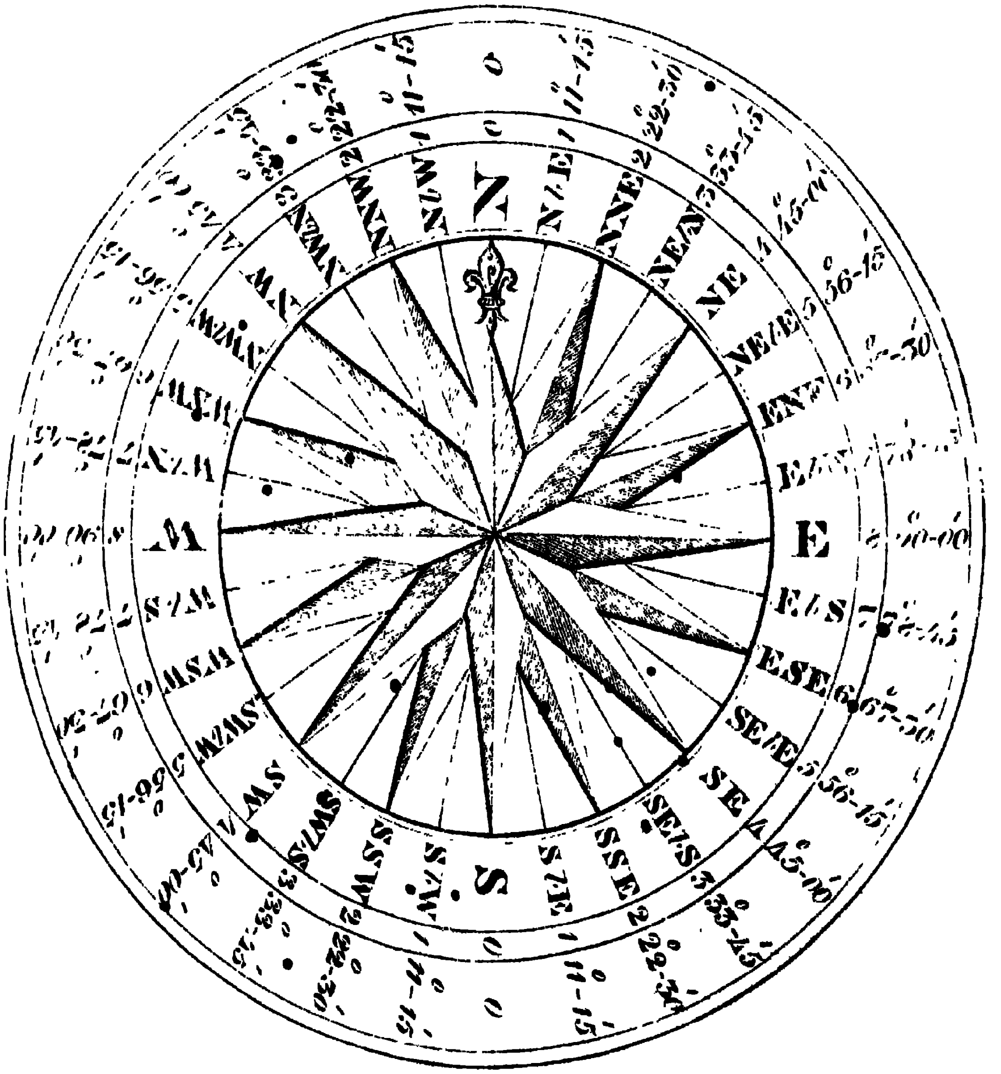
THE OFFSET-STAFF.

The Offset-Staff is an instrument used to measure short distances; and may be in length, 10, 12, or 15 links. It would be advisable to number the links from each end, on opposite sides, with the figures, 1, 2, 3, &c. as the staff, thus marked, will be more convenient for use.

Note.—As the Cross-Staff is sometimes thought incommodious, a small pocket-cross may be so contrived as to be readily fixed, upon occasion, to the Offset-staff. This may be most expeditiously accomplished by means of a hole made through the cross, admitting the top of the staff, to the eighth link, counting from the bottom or piked end at which place there must be attached a small shoulder, upon which the cross will rest.

Plate I.

A Representation
# of the
CARD of the COMPASS with all its POINTS,
and
the Angle which each Point makes
with the Meridian.



THE COMPASS.

THE Compass is an instrument used by surveyors, to point out the range or direction of lines; and also to shew the bearings of objects. The circumference of the card of the compass contains 360°, and is divided into thirty-two equal parts, called Points, each containing 11° 15′.

Of these, the four principal (namely, East, West, North, and South) are called Cardinal Points; from which the names of the others are derived.

To the under-side of the card, and in the direction of its north and south lines, is attached a magnetic bar of hardened steel, called the Needle, by which the north-point is directed toward the northern part of the horizon; and the other points, consequently, to their corresponding ones in the heavens.

The card and needle are suspended on an upright pin, called the Supporter, which is fixed in the bottom of a brass, or wooden, box; and the whole is covered with a plate of glass to prevent the action of the wind upon the card.

Although the compass is divided into thirty-two points, yet surveyors reduce them to eight, namely, the four cardinal, or chief points; and the four midway between them; viz. the north-east, north-west, south-east, and south-west, which may be expressed by their initial letters, as E., W., N., S.; N E., N W.; S E., S W.

Note 1.—A small pocket-compass may be procured for about five shillings, which will answer the purpose of a surveyor; but for the sake of those who may not possess such an instrument, the following methods of finding a meridian line, &c. are given. When a surveyor enters a field, let him call that side, which is next the sun rising, east; then will the opposite side be west; and, in measuring from the east to the west, he will have the north on his right-hand, and the south on his left. If his direction should lie between any two of the above points, as for example, between the north and the west, he may call the range of the line north-west, &c. This method will suffice, when a correct plan is not required. A true meridian, or north and south line, may be found by observing which line or fence points accurately toward the sun at noon, he being then upon the meridian, or full south. Lines, at right-angles to this meridian line, are east and west.

2.—The north-point of the compass does not point exactly to the north-point of the horizon; but inclines, in some places toward the east, and in others toward the west; and this inclination is called the variation of the compass. In most parts of England, the variation is, at this time, more than 24° westerly; so that the true range of any line, or the bearing of any object, will be above two points more toward the east than what is indicated by the compass.

This wonderful phenomenon has perplexed our greatest philosophers; neither Halley, nor the immortal Newton, having been able satisfactorily to account for it.

3.—Some compasses have the cards attached to the bottom of the boxes, and the needles only are suspended upon pins. When this is the case, place the Compass in such a manner that the north-point of the needle may rest 24° to the west of the north-point of the card; and you will thus make an allowance for the *variation*; for in this situation of the Compass, all the points on the card, will be in their true positions.

4.—It is necessary sometimes to get the needle of the Compass retouched with the magnet, in order that it may traverse properly; as the power of the magnet, on the needle, has a tendency, in lapse of time, to decrease.

THE FIELD-BOOK.

SCARCELY any two surveyors set down their field-notes exactly in the same manner. The method, however, now generally adopted, and which is certainly preferable to all others, is to begin at the bottom of the page and write upward.

Each page of the book must be divided into three columns. In the middle column must be set down the distances on the chain-line at which any mark, offset, or other observation is made; and in the right and left-hand columns respectively, those marks, offsets, and observations must be entered.

The crossings of fences, rivers, &c. may be denoted by lines drawn across the middle column, or part of the right and left-hand columns, opposite the distances on the chain-line, at which they are crossed; and the corners of fields, and other remarkable turns in the fences, to which offsets are taken, may be denoted by lines joining or lying in the same relation to the middle column, as the fences, &c. do to the chain-line.

Thus a tolerably accurate representation of the fences, &c. may be sketched in the field, which will very much assist the surveyor in drawing the plan.

With respect to the characters used to denote stations, the letters of the alphabet will do very well, in small surveys; but in those of a larger extent, numeral figures must be used, and the sign + (plus) placed before each figure; thus, + 1, or + 2; which may be read, station first, or cross first; station one, or cross one, &c. Upon the plan they are generally represented by this (⊙) mark.

Most surveyors take the exact range of the first line, and enter it in their field-book; and from it the range of any other may be easily determined. This method I shall adopt in the following work.

The expression, R. off B, or L. off B, &c. denotes that you are to turn to the right or left-hand, and measure from B, &c.

Note 1.—Many surveyors not only begin at the bottom of the field-book, but also at its right-hand side, and write toward the left, which method I always follow myself.

2.—It is useful for a beginner to draw a rough sketch of the field, or estate which he is about to measure; and upon it, to note the stations in the same manner as they are put down in taking the survey. This will materially assist his memory in planning.

3.—The field-book, for practical use, should be made convenient for the pocket, and interleaved with blotting-paper.

4.—The field-notes should always be set down with ink, which may be carried in a bottle suspended from a button of your waistcoat. Double fountain-bottles, such as are used by excise officers, are the best.

DIRECTIONS AND CAUTIONS TO YOUNG SURVEYORS WHEN IN THE FIELD, &c.

In addition to the instruments already described, you must provide ten arrows, each about a foot in length, made of strong wire, and pointed at the bottom. These should be bent in a circular form at the top, for the convenience of holding them, and a piece of red cloth should be attached to each, that they may be more conspicuous among long grass, &c.

Poles, likewise, generally called Ranging-poles, or Station-staves, will be wanted as marks, or objects of direction, each about ten feet in length, piked with iron at the bottom; and having a red or white flag at the top, that they may be better seen at a distance. Thus equipped, and having entered the field, or estate which you are about to survey, first, make yourself acquainted with its form; and then consider in what manner you must run your lines, according to the directions hereafter given in Parts Third Fourth, and Fifth: after which you must proceed in the following manner.

Let your assistant or chain-leader take nine arrows in his left-hand, and one end of the chain with one arrow in his right; then, advancing toward the place directed, at the end of the chain, let him put down the arrow which he holds in his right-hand. This the follower must take up with his chain-hand, when he comes to it; the leader, at the same time, putting down another at the other end of the chain. In this manner he must proceed until he has put down his tenth arrow; then, advancing a chain farther, he must set his foot upon the end of the chain, and call out, "change." The surveyor, or chain-follower, must then come up to him, if he have no offsets to take, and carefully count to him the arrows; and one being put down at the end of the chain, proceed as before, until the whole line be measured.

Each change ought to be entered in the field-book, or a mistake of 10 chains may happen, when the line is very long. The chain-follower ought to be careful that the leader always puts down his arrow perpendicularly, and in a right-line with the object of direction; otherwise the line will be made longer than it is in reality. The follower may direct the leader by the motion of his left-hand; moving it to the right or left, as circumstances require, and always placing his eye and chain-hand directly over the arrow which is stuck in the ground. The leader likewise, as soon as he has put down his arrow, ought to fix his eye upon the object of direction, and go directly toward it. This he may easily effect by finding a tree or a bush beyond the station to which he is going, and in a straight line with it and himself.

In hilly ground, if the follower lose sight of the mark toward which he is going, he must stand over his arrow; and the leader must move to the right or left, till he sees the follower in a direct line between himself and the mark from which they last departed.

The surveyor ought to put down at each station a small stake, called a station-stake, with the number of the station upon it; so that any of the stations may be readily found, if there be occasion to measure the distance between two of them, as a tie or proof-line, &c.

In large surveys, there must be a cross cut in the ground, at each station, making right-angles with the chain-line; so that, if the stake should be pulled up, the cross may still remain, and serve as a director.

When a survey is taken with an intent to draw a finished plan, all remarkable objects should be noted down in the field-book; as roads, stiles, gates, trees, &c.

If the surveyor can conveniently procure two assistants, the one to lead the chain and the other to follow it, it will be much to his advantage; as he will thus be left at liberty to take offsets, note down dimensions, &c. without loss of time.

He ought always to observe to whom the boundaries belong.

If the ditch be in the field which he is about to measure, both it and the hedge usually belong to the adjoining field. This, however, is not always the case; as it sometimes happens that the hedge is on the reverse side of the ditch. It is advisable, therefore, to inquire of some person resident on the spot, concerning the hedges, &c.

In some places, 3 feet from the roots of the quickwood are allowed for the breadth of the ditches; in some 4, in some 5, and in some 6; but 4 feet, or 6 links, are commonly allowed for ditches between neighbouring estates, and 7 links for ditches adjoining roads, commons, waste lands, &c.

The ditches and fences must always be measured with the fields to which they belong, when the whole quantity of land is required; but in measuring crops of corn, turnips, &c. only so much must be measured as is, or has been occupied by the corn, &c.

Upon the surveyor depends all the care of measuring, remarking, noting down, &c. It absolutely behoves him, therefore, to be, not only particularly careful in his entries, and correct in his dimensions; but also extremely accurate in his constructions and calculations.

Note.—The line in which you have the misfortune to lose an arrow, must be remeasured.

DIRECTIONS CONCERNING SCALES, LAYING DOWN FIGURES, &c.

ANY scale of equal parts may be used in planning, or laying down figures; but that, which is most convenient for use, is the ivory plotting-scale, so divided on its edges, that you may prick off distances by laying it upon the line.

In laying down an offset by the plotting-scale, it is best, first, to prick off the base-line; and then upon it make a small pencil dot at every place where a perpendicular must be erected.

This being done, lay the scale across the base, so that the line which goes across the scale, marked with *oo*, may coincide with it, the edge of the scale at the same time touching one of the dots. From the dot, by the edge of the scale, draw a line, (which will be perpendicular to the base,) and upon it prick off the offset; or it may be pricked off without drawing a line.

Proceed thus, till all the perpendiculars are erected; and then draw the fence through each of their extremities. If the fence be curved, it must be drawn by a steady hand, in the same manner as the circumference of an ellipse. *(See page 19.)*

In planning, or laying down figures relating to surveying, the upper part of the paper or book used should always, if possible, represent the north. All the fences and chain-lines should first be pencilled: the first should then be drawn, and the latter dotted with ink. Great accuracy is required in the construction of figures, when the perpendiculars, &c. are to be measured by the scale. The lines should be very fine; the dots at the stations very small; and the points of the compasses very sharp, in order that distances may be taken from the scale with the utmost correctness. The scale should never be smaller than two chains to an inch; for when its divisions are large, figures may be constructed with much more accuracy, and their perpendiculars, &c. measured with much greater exactness.

After having found the area of any field or estate, you may, however, lay it down by any scale that will reduce it to a more convenient size. Or you may divide the dimensions by 2, 3, 4, &c. in order to make them of a proper size to be laid down by a scale of 2, 3, or 4 chains to an inch.

Note 1.—A plotting-scale divided into two chains to an inch on one of its edges, and four on the other, is perhaps most useful for a school-boy; but practical surveyors prefer those which have both their edges divided in the same manner, because they are more convenient in planning; and a mistake cannot be made by using one edge instead of the other.

2.—An instrument called a Pricker, which may be made by putting a fine needle into a wooden haft, is used by some persons, in pricking off distances from the plotting-scale; but a hard black-lead pencil, finely pointed, is preferable, because it does not injure the paper.

LAND-SURVEYING.

Part the Third.

To Survey with the Chain and Cross; also, to Measure Meres, Woods, and Lines upon which there are Impediments.

CONFORMABLY to a statute of 34 Henry VIII. an acre is equal to 10 square chains; that is, 10 chains in length and 1 in breadth; or 220 × 22 = 4840 square yards; or 40 × 4 = 160 square rods, poles, or perches.

A statute-pole or perch is 16½ feet long; but in different parts of the kingdom there are, by custom, poles of different lengths; as 15, 18, 21 feet, &c.

The various dimensions of a piece of land are taken in lineal measure, from which its area or content is calculated.

Note.—The method of reducing statute-measure to customary, and the contrary, may be seen in Part the Sixth.

A TABLE OF LINEAL MEASURES

Inches. 7.92=	*Link.* 1						
12	1.5151=	*Foot.* 1					
36	4.5454	3=	*Yard.* 1				
198	25	16.5	5.5=	*Stat. Perch.* 1			
792	100	66	22	4=	*Chain.* 1		
7920	1000	660	220	40	10=	*Furl.* 1	
63360	8000	5280	1760	320	80	8=	*Mile.* 1

Note.—Seven yards make one rood of fencing or ditching.

A TABLE OF SQUARE MEASURES.

SQUARE *Inches.*	SQUARE *Link.*	SQUARE *Foot.*	SQUARE *Yard.*	SQUARE *Perch.*	SQUARE *Chain.*	SQUARE *Rood.*	SQUARE *Acre.*	SQUARE *Mile.*
62.7264=	1							
144	2.2956=	1						
1296	20.6611	9=	1					
39204	625	272.25	30.25=	1				
627264	10000	4356	484	16=	1			
1568160	25000	10890	1210	40	2.5=	1		
6272640	100000	43560	4840	160	10	4=	1	
4014489600	64000000	27878400	3097600	102400	6400	2560	640=	1

PROBLEM I.

SQUARE FIELDS.

When you enter a field, which has the appearance of a square, (for few are accurately such,) fix your cross-staff in a corner of it, and if the two sides be at right-angles, measure one of them, and enter its dimensions in your field-book. Proceed in like manner with each angle and side; and if you find all the angles right-angles, and all the sides equal, the figure is a square.

TO COMPUTE THE CONTENT.

Rule.—Multiply the side into itself, and the product will be the area, in square links. Cut off five places as decimals, toward the right-hand of the product, and those on the left will express the number of acres.

Reduce these decimals into roods and perches, by multiplying them successively by 4 and 40, and cutting off five figures on the right as before, in each product.

If the dimensions be in yards, divide the square of the side by 4840, and the quotient will be acres.

Reduce the remainder, if any, into roods and perches, by multiplying it successively by 4 and by 40, as before.

Note 1.—Any person who is not in possession of a chain, may take the dimensions in yards, where accuracy is not required.

2.—In measuring with the chain, it is best to set down the number of links, as 956: where, instead of reading 956 links, read 9 chains and 56 links.

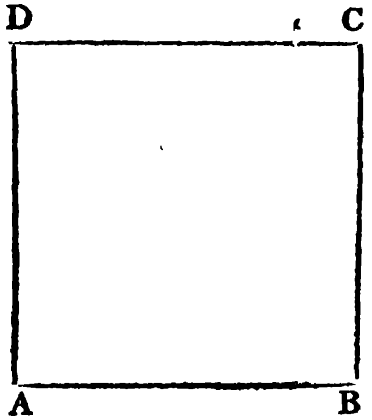
3.—The dimensions of small parcels of land, sold by the square yard, for building, &c. should be taken in feet and inches, with a measuring-tape. Paving, digging, &c. should be measured in the same manner.

4.—In computing the contents of fields, it is customary, among practical surveyors, to call the remainder a perch, if it exceeds half a one; but if it be less than half a perch, it is considered as nothing.

5.—The learner should carefully *work over*, and *put down* all the solutions given in this book, in order that he may better understand the different methods of calculation.

EXAMPLES.

1. What is the area in acres of the square A B C D, whose side is 956 links?



956
956
5736
4780
8604
9.13936
4
.55744
40
22.29760 Area 9A. 0R. 22P.

2. Required the area in acres of the square, whose side is 264 yards.

264
264
1056
1584
528
4840)69696(14
4840
21296
19360
.1936
4
4840)7744(1
4840
2904
40
484,0)11616,0(24
968
.1936
1936 Area 14A. 1R. 24P.

3. If the side of a square be 1567 links; what is its area in acres? Ans. 24A. 2R. 9P.

4. If the side of a square be 263 yards; what is its area in acres? Ans. 14A. 1R. 6P.

PROBLEM II.

RECTANGULAR FIELDS.

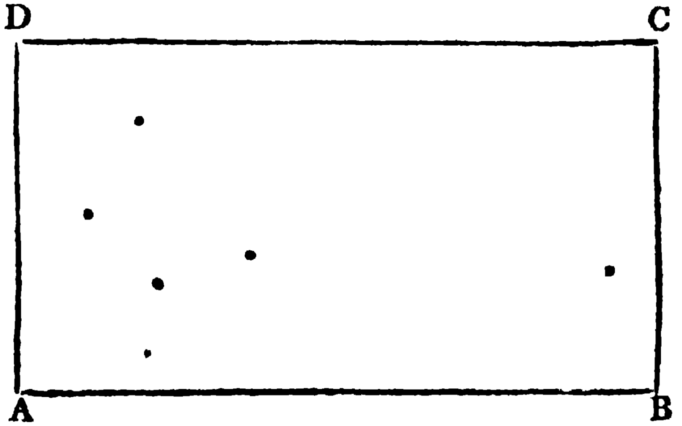
When you enter a field which has the appearance of a rectangle, try each angle, and measure each side, as before; and if you find all the angles right-angles, and the opposite sides equal, the figure is a rectangle.

TO COMPUTE THE CONTENT.

Rule.—Multiply the length by the breadth, and the product will be the area.

EXAMPLES.

1. What is the area of the rectangle A B C D, whose length A B is 1235 links, and breadth A D, 557 links?



1235
557
8645
6175
6175
6.87895
4
3.51580
40
20.63200 Area 6A. 3R. 21P.

2. Required the area of a rectangle, whose length is 235, and breadth 162 yards.

```
       235
       162
      ----
       470
      1410
      235
     -------
484,0)3807,0(7
      3388
      ----
      .419
         4
      ----
  484)1676(3
      1452
      ----
      .224
        40
      -----
  484)8960(18
       484
       ----
       4120
       3872
       ----
       .248 Ans. 7A. 3R. 18P.
       ====
```

3. The length of a rectangular field is 1225 links, and its breadth 613 links; required the plan and area.

Area 7A. 2R. 1P.

4. If the length of a rectangle be 135, and breadth 50 yards; what is its area? Ans. 1A. 1R. 23P.

Note.—As squares and rectangles seldom occur in surveying, it is much more expeditious to treat every field of four sides as a trapezium. (See Problem 4.)

PROBLEM III.

TRIANGULAR FIELDS.

When you have to survey a field in the form of a triangle, set up a pole at each corner, when there are no natural marks. Then measure along the base till you come to the point, where you think a perpendicular will fall from the opposite angle. There plant your cross, and turn its index till the mark at each end of the base can be seen through one of the grooves. Then apply your eye to the other groove, and if you see the mark at the opposite angle, you are in the right place to measure the perpendicular; if not, move the instrument backward or forward, along the line, till you can see the three marks as above directed. Enter in your field-book the distance from the end of the base to the cross, and the length of the perpendicular. Then measure the remainder of the base.

Note 1.—Be especially careful, that in measuring the two parts of the base and the perpendicular, no confusion of arrows take place.

2.—In finding perpendiculars by the cross, you must always proceed as above directed.

CONSTRUCTION.

Having the place of the perpendicular, the figure may be easily constructed, as follows. From any scale of equal parts, lay off the base; erect the perpendicular at its proper point; draw a line from each end of the base to the end of the perpendicular, and the figure will be completed.

Note.—Having the diagonal, the two perpendiculars, and the place of each perpendicular given, you may construct any trapezium in the same manner.

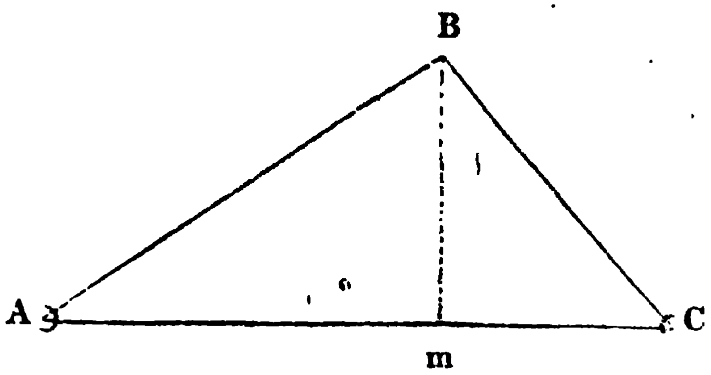
TO COMPUTE THE CONTENT.

RULE.—Multiply the base and perpendicular together, divide the product by 2, and the quotient will be the area.

Or, multiply half the base by the whole perpendicular, or the whole base by half the perpendicular, and the product will be the area.

EXAMPLES.

1. It is required to survey the triangular field A B C, and to find its area.



Measure from A toward C, and when you come to m, for instance, at 935 links; try with your cross; and if this be the point for the perpendicular, measure m B = 625 links. Return and measure m C = 628 links, making the whole base = 1563 links; then construct the figure, and find its area.

1563 base.
625 per.
7815
3126
9378
2)976875
4.88437
4
3.53748
40
21.49920 Area 4A. 3R. 21P.

2. The distance between the beginning of the base, and the place of the perpendicular is 125, the perpendicular 82, and the whole base 318 yards; what is the area of the triangle?

```
            318 base.
             82 per.
            ---
            636
          2544
          -----
        2)26076
   4840)13038(2
         9680
         -----
         . 3358
              4
         -----
   4840)13432(2
         9680
         -----
         . 3752
             40
         -----
  484,0)15008,0(31
        1452
        -----
        . . 488
            484
            ---
        . . 4 Ans. 2A. 2R. 31P.
```

3. Measuring along the base of a triangle 862 links, I found the true place of the perpendicular, and the perpendicular itself = 995 links; the remainder of the base measured 1110 links; what is the area of the triangle? Ans. 9A. 3R. 10P.

4. Measuring along the base of a triangular field, I found the perpendicular to rise at 865, and its length 615 links; the remainder of the base measured 569 links; required the plan and area. Area 4A. 2R. 20P.

Note.—If the examples in this Problem, or any of the following Problems, be thought too few, more may easily be supplied by the Teacher sketching fields, at pleasure, with his pen, which the Learner may measure by a scale. This method will be found very advantageous; as it will give the Learner a good idea in what manner he must run his lines, take his dimensions, and enter his notes, when he commences field-practice.

PROBLEM IV.

FIELDS IN THE FORM OF A TRAPEZIUM.

A quadrilateral field, having unequal sides, may be surveyed by measuring a diagonal. This divides it into two triangles, to each of which it serves as a base.

TO COMPUTE THE CONTENT.

Rule.—Multiply the sum of the two perpendiculars by the diagonal, divide the product by 2, and the quotient will be the area.

Note 1.—Always make choice of the longer diagonal, because the longer the base line of a triangle, the more obtuse is its subtending angle; and, consequently, there is the less chance to mistake, as the perpendicular will be shorter, and its place more easily and more accurately determined. After finishing the surveying, if you choose, measure the other diagonal, which will enable you to prove your work. *(See Problems I. and II. Part IV.)*

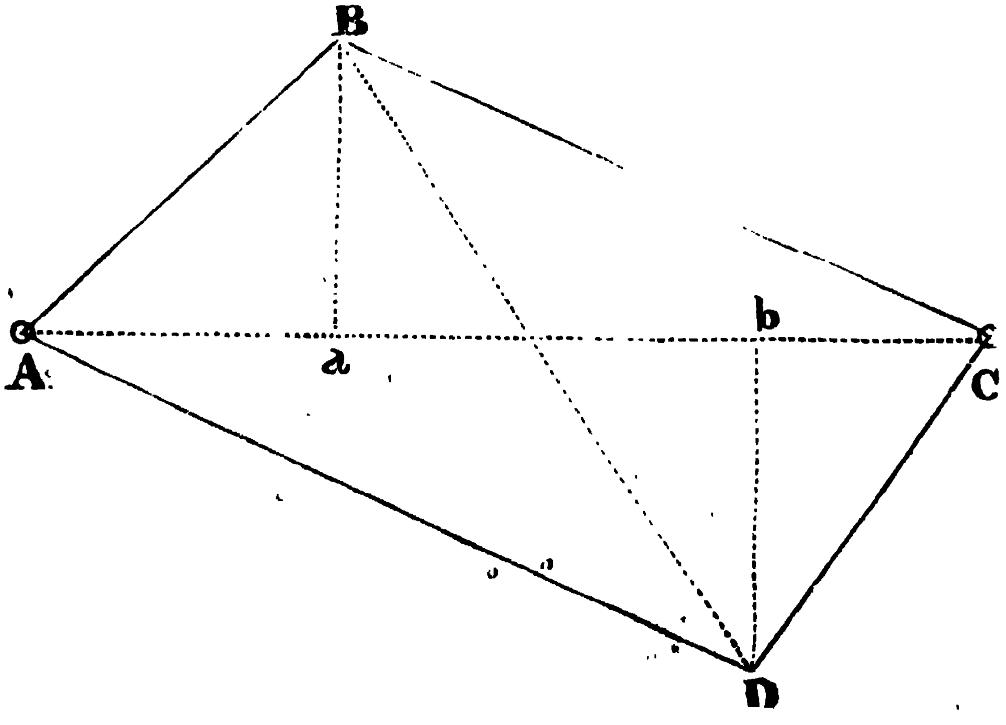
2.—If a field be very long, or elevated in the middle, so that you cannot see from one end to the other, it may be divided into two, or more trapeziums. Or you may range your lines over the hill, as directed in Part the Fifth.

3.—When two perpendiculars cannot be taken upon either of the diagonals, such fields must be divided into two triangles by measuring a diagonal for the base of one triangle, and one side of the field for the base of the other. (See Example VI.)

4.—Unskilful surveyors affect to reduce trapeziums into squares, or rectangles, by measuring all the sides, adding each two opposite sides together, and taking half their sum respectively for a mean length and breadth; but this method leads to very erroneous results. (See Part IV. Prob. 2.)

EXAMPLES.

1. It is required to survey the trapezium A B C D, and find its area.



Measure from A toward C. Finding the perpendicular a B to rise at 473, and its length 437 links; return, and continue toward C, till you come to the place where the second perpendicular b D rises. There note down its distance from A, 1128 links; measure b D = 508 links; then complete the measuring of the diagonal to C, and let the whole be 1490 links.

After this, measure the diagonal B D, for a proof-line, which you will find 1152 links.

```
   437 } per.
   508 }
   ---
   945   sum.
  1490   diag.
 -----
 85050
 3780
 945
 -------
2)1408050
 -------
 7.04025
       4
 -------
 0.16100
      40
 -------
 6.44000 Area 7A. 0R. 6P.
```

2. In taking the dimensions of a trapezium, I found the first perpendicular to rise at 539, and to measure 725 links; the second at 1890, and to measure 832 links; the whole diagonal measured 2456 links; required the area of the trapezium?

Ans. 19A. 0R. 19P.

3. The first perpendicular of a trapezium rises at 467, and measures 545 links; the second at 1418, and measures 467 links; required its area, the whole diagonal being 1840 links?

Ans. 9A. 1R. 9P.

4. Lay down a field, and find its area, from the following notes.

	A D	
	1625	
	1252	523 C.
B 639	636	
Begin	at A.	Range W.
Per. on the left	Base Line or Diag.	Per. on the right.

Area 9A. 1R. 30½P.

5. Required the plan and area of a field, from the following dimensions.

	A D	Diag.
	1744	
C 545	1365	
	546	652 B.
Begin	at A	Range E.

Area 10A. 1R. 30P.

6. Lay down a field, and find its area from the following notes.

	D B	Diag.
	1095	
	488	298 C.
	L.offD.	
	A D	Side.
	1358	
B 532	410	
Begin	at A.	Range E.

Answer.
Doubles areas.
722456 Triangle A B D.
326310 Triangle B C D.
Whole area 5A. 0R. 39P.

ANOTHER METHOD.

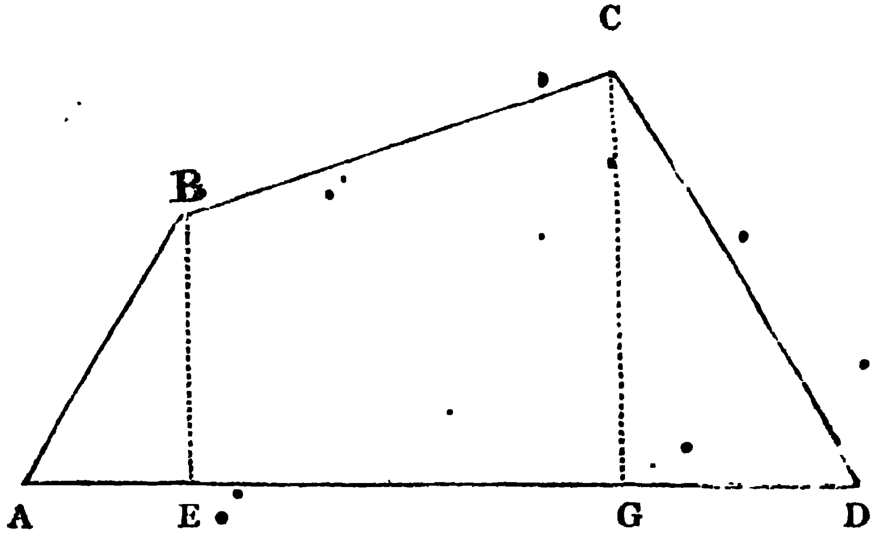
A field of four sides may sometimes be surveyed by dividing it into two right-angled triangles, and a trapezoid.

TO COMPUTE THE CONTENT.

RULE.—Multiply the sum of the two perpendiculars by their distance upon the base-line, and the product will be double the area of the trapezoid. The area of each triangle must be found as before.

EXAMPLES.

1. It is required to survey the annexed figure, and find its area:



Measure the base A D, and enter in your field-book where the two perpendiculars rise, &c. as in the following notes.

Per.	Base.
	A D = 1326
G C = 645	A G = 952
E B = 422	A E = 265

Triangle A B E.
422 per.
265 base.
2110
2532
844
111830

Triangle G C D.
645 per.
374 base.
2580
4515
1935
241230

Trapezoid E B C G.
422 } per.
645 }
1067 sum.
687 base.
7469
8536
6402
733029

733029 }
241230 } Double areas collected.
111830 }
2)1086089
5.43044
4
1.72176
40
28.87040 Area 5A. 1R. 29P.

2. Required the plan and area of a field, from the following notes.

	A B	
	1681	
E	1015	564 D.
G	432	705 C.
Begin	at A.	Range W.
Per. on the left.	Base.	Per. on the right.

Area 7A. 0R. 16P.

3. Lay down a field, and find its area, from the following dimensions.

	A B	
	1546	
D 625	1146	E.
C 883	564	G.
Begin	at A.	Range E.

Area 8A. 0R. 20½P.

PROBLEM V.

FIELDS COMPREHENDED UNDER MORE THAN FOUR STRAIGHT SIDES.

Any piece of land, consisting of more than four sides, may be surveyed by reducing it into triangles and trapeziums.

Thus, a field of five sides may be reduced into a triangle and a trapezium; of six, into two trapeziums; of seven, into two trapeziums and a triangle; of eight, into three trapeziums, &c.

The propriety of dividing fields in this manner, depends entirely on the relation which the angles have to one another: it is, therefore, sometimes more accurate to divide them into triangles.

TO COMPUTE THE CONTENT.

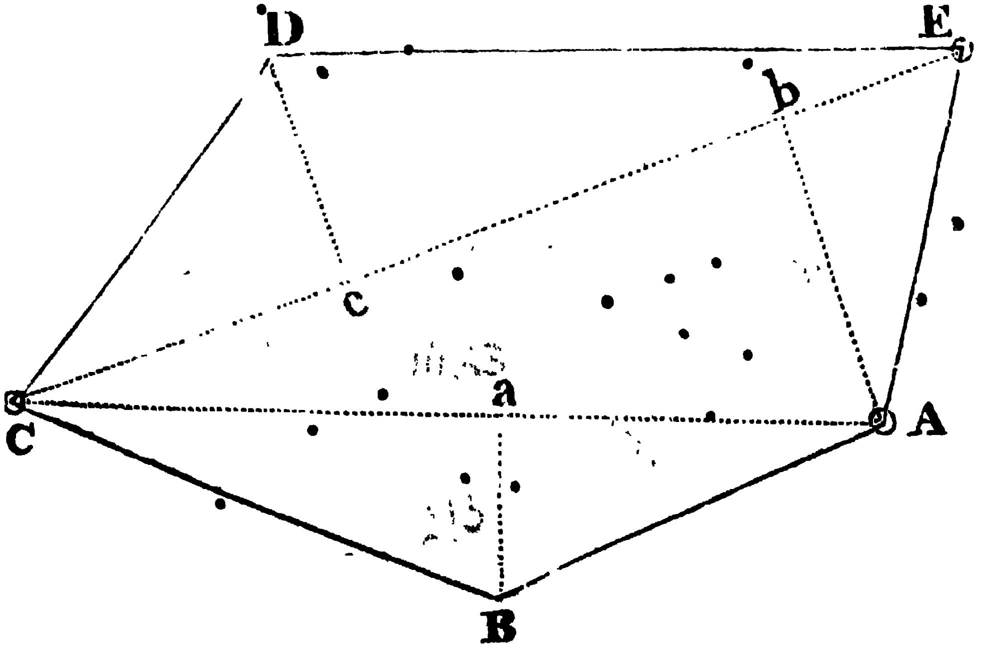
Rule.—By the rules given in the last two problems, find the double area of each triangle and trapezium contained in the figure.

Collect all the double areas into one sum, which divide by 2, and the quotient will be the whole area.

EXAMPLES.

1. Lay down a field, and find its area from the following notes.

	C E	
	1666	Diag.
	1326	496 A.
	1000	
D 376	573	
	R. off C	
	A C	
	1433	Diag.
	1000	
B 273	643	
Begin	at A.	Range W.
Per. on the left.	Diag.	Per. on the right.



CONSTRUCTION.

From the notes, the figure obviously consists of five sides, and is divided into a triangle and a trapezium. Draw the base A C, which make = 1433 links; at 643 links, let fall the perpendicular a B, upon which lay off 273 links; join A B and C B, and the triangle is completed. Then, with A as a centre, and 496 links in your compasses as a radius, describe an arc; and with C as a centre, and 1326 as a radius, describe another arc, intersecting the former in b.—Through b draw the diagonal C E = 1666 links; upon which, at 573 links, erect the perpendicular c D = 376 links. Join C D, D E, and E A, and the figure will be completed.

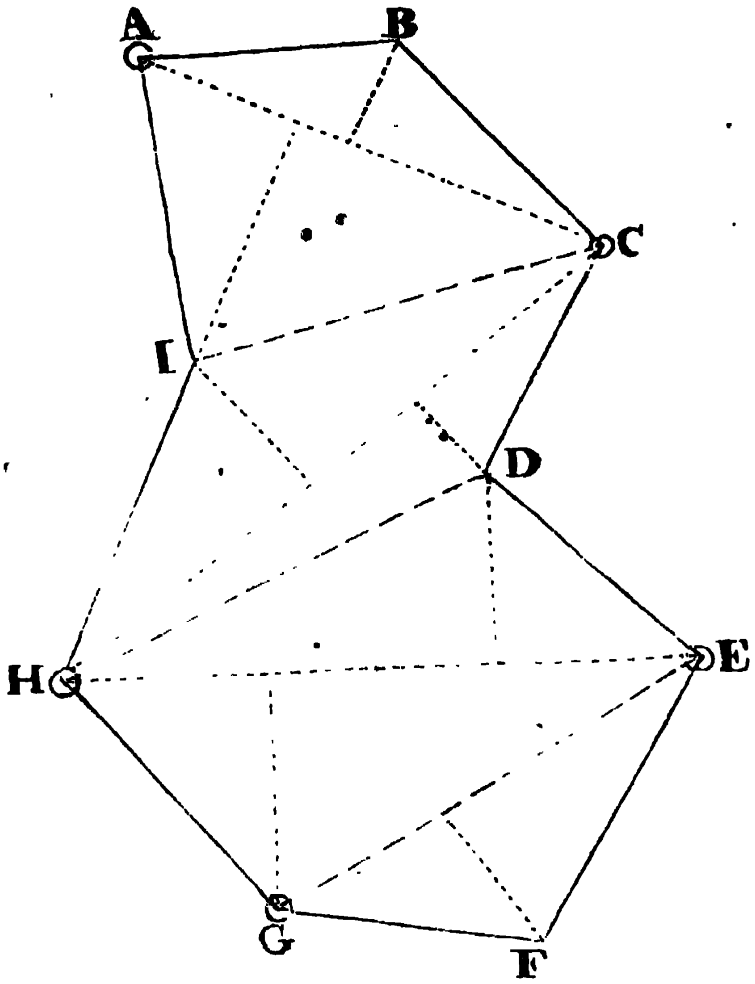
Note.—If the learner fully comprehend the above construction, he will not find it difficult to lay down the figures belonging to the following examples; as the same process will succeed in all similar cases.

Triangle A B C.	Trapezium A C D E.
1433 base.	376 } per.
273 per.	496 }
4299	872 sum.
10031	1666 diag.
2866	5232
391209	5232
	5232
	872
	1452752

391209 } Double areas
1452752 } collected.
2)1843961
9.21980
4
.87920
40
35.16800 Area 9A. 0R. 35P.

2. Lay down a field, and find its area, from the following dimensions.

	E G	
	1150	Diag.
	1000	
F 400	717	
	R. off E	
	H E	
	1474	Diag.
	1000	
D 465	975	
	465	575 G.
	L. off H	
	C H	
	1635	Diag.
	1000	
	910	390 I.
D 235	575	
	R. off C	
	A C	
	1165	Diag.
	1000	
B 263	530	
	400	630 I.
Begin	at A.	Range E. SE.



Trapezium A B C I.
630 } per.
263
893 sum.
1165 diag.
4465
5358
893
893
1040345

Trapezium C D H I.
235 } per.
390
625 sum.
1635 diag.
3125
1875
3750
625
1021875

Trapezium D E G H.

575 } per.
465 }

1040 sum.
1474 diag.

4160
7280
4160
1040

1532960

Triangle E F G.

1150 base.
400 per.

460000

1040345 }
1021875 } Double areas
1532960 } collected.
460000 }

2)4055180

20.27590
4

1.10360
40

4.14400 Area 20A. 1R. 4P.

3. Required the plan and area of a field, from the following dimensions.

	B A	
	1008	
E 195	466	
Return	to B.	
	A D	Diag.
	1345	
C 415	944	
	855	536 B.
Begin	at A.	Range W.

Answer.

Double areas.
1279095 Trapezium A B D C.
196560 Triangle A E B.

Whole area 7A. 1R. 20½P.

4. Lay down a field, and find its area, from the following notes.

	D F	Diag.
	1940	
	1040	362 B.
E 581	825	
	R. off D	
	A D	Diag.
	1488	
C 322	772	
	606	665 B.
Begin	at A.	Range W.

Answer.

Double areas.

1468656 Trapezium A B D C.

1829420 Trapezium D E F B.

Whole area 16A. 1R. 38P.

5. Draw a plan of a field, and find its area, from the following dimensions.

	H K	Diag.
	1285	
I 382	740	
	600	162 G.
	R. off H.	
	F H	Diag.
	1223	
E 661	803	
	666	276 G.
	L. off F.	
	D F	Diag.
	1716	
	1080	246 B.
E 403	761	
	R. off D.	
	A D	Diag.
	1547	
C 603	1023	
	525	488 B.
Begin	at A.	Range

Answer.

Double areas.
1687777 Trapezium A B D C.
1123980 Trapezium D E F B.
1145951 Trapezium F G H E.
699040 Trapezium H G K I.
Whole area 23A. 1R. 5P.

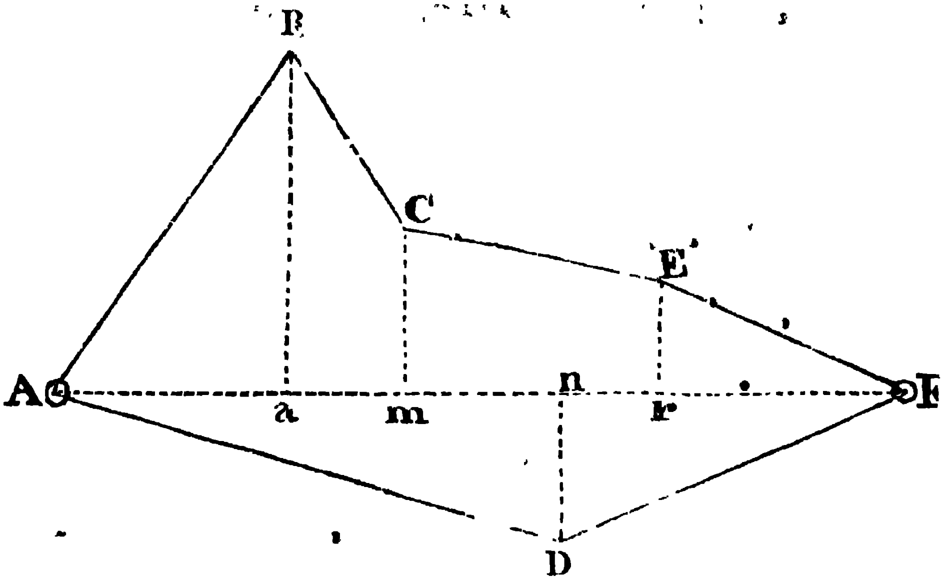
ANOTHER METHOD.

A field consisting of five, six, seven, or more sides, may sometimes be surveyed by measuring one diagonal, and upon it erecting perpendiculars to all the opposite angles, on each side. This process will divide the whole field into right-angled triangles, and trapezoids, the areas of which must be found as before.

EXAMPLES.

Lay down a field, and find its area, from the following notes.

	A F	
	1896	Diag.
E 259	1342	
	1132	325 D.
	1000	
C 367	763	
B 756	522	
Begin at A.	Range E.	



Triangle A B a.
756 per.
522 base.
1512
1512
3780
394632

Trapezoid a B C m.
756 } per.
367 }
1123 sum.
241 base.
1123
4492
2246
270643

Trapezoid m C E r.
367 } per.
259 }
626 sum.
579 base.
5634
4382
3130
362454

Triangle r E F
554 base.
259 per.
4986
2770
1108
143486

Triangle A D F
1896 base.
325 per.
9480
3792
5688
616200

394632 }
270643 }
362454 } Double areas collected.
143486 }
616200 }
2)1787415
8.93707
4
3.74828
40
29.93120

Area 8A. 3R. 30P.

2. Lay down a field, and find its area, from the following dimensions

	A K.	Diag.
0	1700	0
I 290	1465	d
w	1368	365 H
r	1055	381 G
F 144	986	n
m	794	218 E
e	515	350 D
C 250	444	c
a	150	275 B
0	000	0
Begin	at A.	Range W.

Answer.

Triangles and Trapezoids on the Right,
Double areas.

41250 Triangle A B a.
228125 Trapezoid a B D e.
158472 Trapezoid e D E m.
156339 Trapezoid m E G r.
233498 Trapezoid r G H w.
121180 Triangle w H K.
938864 sum.

Triangles and Trapezoids on the Left,
Double areas.

111000 Triangle A C c.
213548 Trapezoid c C F n.
207886 Trapezoid n F I d.
68150 Triangle d I K.
600584 sum.
938864 sum brought down.
1539448 sum total.

Whole area 7A. 2R. 31½P.

3. It is required to lay down a field, and find its area, from the following notes.

	A L.	Diag.
M 460	2150	0
d	1670	295 K
I 395	1530	w
r	1345	160 H
G 670	1275	n
F 400	880	m
e	780	270 E
c	465	150 D
C 405	305	a
0	000	300 B
Begin	at A.	Range E

Answer.

Triangles and Trapezoids on the Right.

Double areas.

209250	Trapezoid A B D c.
132300	Trapezoid c D E e.
242950	Trapezoid e E H r.
147875	Trapezoid r H K d.
141600	Triangle d K L.
873975	sum.

Triangles and Trapezoids on the Left

Double areas.

123525	Triangle A a C.
462875	Trapezoid a C F m.
422650	Trapezoid m F G n.
271575	Trapezoid n G I w.
530100	Trapezoid w I M L
1810725	sum.
873975	sum brought down.
2684700	sum total.

Whole area 13A. 1R. 27¾P.

PROBLEM VI.

FIELDS COMPREHENDED UNDER ANY NUMBER OF CROOKED OR CURVED SIDES.

When a field is bounded by crooked fences, you must measure a line as near to each as the angles or curves will permit;

in doing which, you must take an offset to each corner or angle in the fence. Where the fences are curved, those offsets must be so taken, that a right line drawn from the end of any one perpendicular to the end of the next, on each side, would neither exclude any part of the land to be measured, nor include any of that which is adjacent. Perpendiculars thus erected, will divide the whole offset into right-angled triangles and trapezoids, the areas of which must be found as before.

Note 1.—If the curves be so large, that many of the offsets would be 2, 3, 4, or 5 chains long; it will be more expeditious and accurate, to measure the base without taking any offsets, except such as are short, leaving stations in proper places along the base, to which, when you have obtained its length, you may return, and from them run fresh station-lines to some convenient point, or points, in the curved fence. Upon these lines, take offsets as before. (See Example III.)

2.—If any of the fences be curved inward, it is frequently most convenient to measure a line on the outside of the field, and upon it erect perpendiculars to the curved fence, which, in this case, are called insets; and the area thus included must be subtracted from the area of the whole figure. (See Example IV.)

3.—When the fences and ditches are to be measured with the field to which they belong, it is generally most practicable to fix the stations within the fences, at a little distance from the corners, and then to measure to the roots of the quick-wood; adding or subtracting 5 or 6 links, according to the custom of the place, for the breadth of the ditch. (See Example V.)

4.—When the offsets are small, their places on the base-line may be determined by laying the offset-staff at right angles upon the chain; but when large, and accuracy is required, they must be found by the cross, and measured by the chain.

5.—The base of each triangle and trapezoid, forming an offset, may be found by subtracting the distances on the chain-line, from each other.

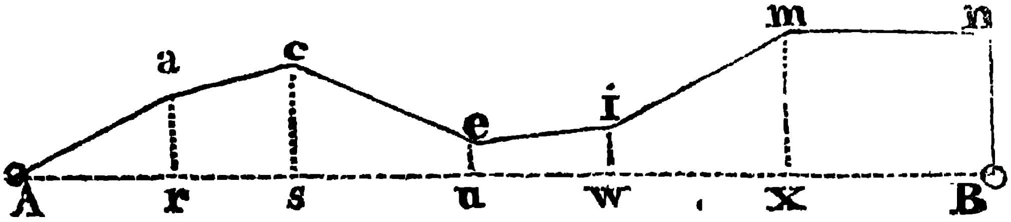
6.—The methods frequently used, by unskilful surveyors, to find the area of offsets, are very erroneous. Some divide the sum of the offsets by their number, for a mean breadth; others divide that sum by one more than their number, for a mean breadth; and both multiply the whole base by the mean breadth, thus supposed to be found, for the area of the whole offset. The first of these methods generally gives the area too much; and the second sometimes too much and sometimes too little. A third method, which is usually more accurate than either of the preceding ones, is to set down each offset twice (accounting that one, where the boundary meets the station-line) except the first and last, which are only entered once. The sum of these offsets is then multiplied by the base, the product divided by the number of offsets set down, and the quotient given is the area required.

7.—Directions for laying down offsets by a plotting-scale, may be seen in Part the Second.

EXAMPLES.

1. Lay down the figure of a right-line offset, and find its area, from the following notes.

	A B
n 200	1569
m 210	1249
	1000
i 70	952
e 50	745
c 159	450
a 120	265
0	000
Begin at	A. Range E.



BY THE TRUE METHOD.

Triangle A r.a.
265 base.
120 per.
5300
265
31800

Trapezoid r a c s.
120 } per.
159 }
279 sum.
185 base.
1395
2232
279
51615

Trapezoid s c e u.

$$\begin{array}{rl}
\left.\begin{array}{r}159\\50\end{array}\right\} & \text{per.}\\
209 & \text{sum.}\\
295 & \text{base.}\\
1045 & \\
1881 & \\
418 & \\
\hline
61655 &
\end{array}$$

Trapezoid u e i w.

$$\begin{array}{rl}
\left.\begin{array}{r}50\\70\end{array}\right\} & \text{per.}\\
\hline
120 & \text{sum.}\\
207 & \text{base.}\\
\hline
840 & \\
240 & \\
\hline
24840 &
\end{array}$$

Trapezoid w i m x.

$$\begin{array}{rl}
\left.\begin{array}{r}70\\210\end{array}\right\} & \text{per.}\\
\hline
280 & \text{sum.}\\
297 & \text{base.}\\
\hline
1960 & \\
2520 & \\
560 & \\
\hline
83160 &
\end{array}$$

Trapezoid x m n B.

$$\begin{array}{rl}
\left.\begin{array}{r}210\\200\end{array}\right\} & \text{per.}\\
410 & \text{sum.}\\
320 & \text{base.}\\
8200 & \\
123 & \\
\hline
131200 &
\end{array}$$

$$\begin{array}{rl}
31800 & \\
51615 & \\
61655 & \text{Double areas}\\
24840 & \text{collected.}\\
83160 & \\
131200 & \\
\hline
2)\overline{384270} & \\
\hline
1.92135 & \\
4 & \\
\hline
3.68540 & \\
40 & \\
\hline
27.41600 &
\end{array}$$

Hence the true area is 1A. 3R. 27P.

BY THE FIRST FALSE METHOD.

120	1569 length.
159	134.8 breadth
50	12552
70	6276
210	4707
200	1569
6)809	2.115012
134.8 mean breadth.	4
	.460048
	40
	18.401920

Here the area appears to be 2A. 0R. 18P., which is too much by 31P.

BY THE SECOND FALSE METHOD.

120	1569 length.
159	115.5 breadth.
50	7845
70	7845
210	1569
200	1569
7)809	1.812195
115.5 mean breadth.	4
	3.248780
	40
	9.951200

Here the area appears to be 1A. 3R. 10P., which is too little by 17P.

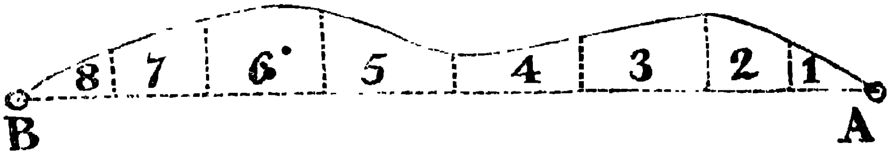
BY THE THIRD FALSE METHOD.

0	1569 length.
120	1418 sum.
120	12552
159	1569
159	6276
50	1569
50	12)22.24842
70	1.85403
70	4
210	3.41612
210	40
200	16.64480
1418 sum	

Here the area appears to be 1A. 3R. 16P., which is too little by 11P.

2. Lay down a curve-line offset, and find its area, from the following notes.

	A B	
	1012	0
	892	53
	786	80
	645	95
	500	45
	350	63
	200	84
	100	52
	000	0
Begin at	A. Range	W.



52
100
5200 No. 1.

52
84
136
100
13600 No. 2.

84
63
147
150
7350
147
22050 No. 3.

63
45
108
150
5400
108
16200 No. 4.

45
95
140
145
700
56
14
20300 No. 5.

95
80
175
141
175
700
175
24675 No. 6.

80
53
133
106
798
13
14098 No. 7.

53
120
1060
53
6360 No. 8.

5200 ⎫
13600
22050
16200 ⎬ Double areas
20300 ⎪ collected.
24675
14098
6360 ⎭
2)122483
.61241
4
2.44964
40
17.98560 Area 2R. 18P.

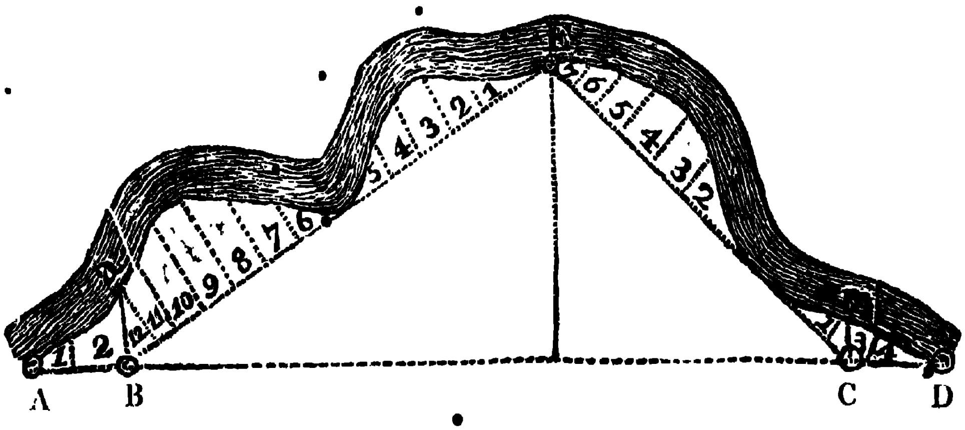
3. Lay down the figure of a piece of land adjoining a river, and find its area, from the following notes.

	E B		
	1350	0	
	1265	140 a	
	1200	170	
	1100	244	
	1000	250	
	900	190	River.
	800	100	
	700	0	
	600	0	
	500	94	
	400	142	
	300	153	
	200	70	
	000	0	
Left off F,	and go	S W. to B.	

	C E	
	1060	0
	1000	50
	900	110
	800	154
	700	173
	600	142
	400	0
	200	0
	70	82 m
	000	0
Return	to C, and go	N W. to E.
	A D	
0	2463	
70	2300	
m 110	2200	C
	2000	
E 698	1410	
	1000	
a 165	250	B
60	100	
0	000	
Begin	at A. Range	E.

River 100 links in breadth.

River.



Triangle B C E.

1950 base.
698 per.
15600
1755
1170
1361100

Offsets taken on the line A D.

60
100
6000 No 1.

60
165
225
150
11250
225
33750 No. 2.

110
70
180
100
18000 No. 3.

163
70
11410 No. 4.

6000 No. 1.
33750 —— 2.
18000 —— 3.
11410 —— 4.
69160 sum.

Offsets taken on the line C E.

82
200
16400 No. 1.

142
200
28400 No. 2.

142
173
315
100
31500 No. 3.

173
154
327
100
32700 No. 4.

154
110
264
100
26400 No. 5.

110
50
160
100
16000 No. 6.

60
50
3000 No. 7.

16400 No. 1.
28400 —— 2.
31500 —— 3.
32700 —— 4.
26400 —— 5.
16000 —— 6.
3000 —— 7.
154400 sum.

Offsets taken on the line E B.

70
200
14000 No. 1.

70
153
223
100
22300 No. 2.

153
142
295
100
29500 No. 3.

142
94
236
100
23600 No. 4.

94
100
9400 No. 5.

100
100
10000 No. 6.

100
190
290
100
29000 No. 7.

190
250
440
100
44000 No. 8.

250
244
494
100
49400 No. 9.

244
170
414
100
41400 No. 10.

170
140
310
65
1550
186
20150 No. 11.

85
140
3400
85
11900 No. 12.

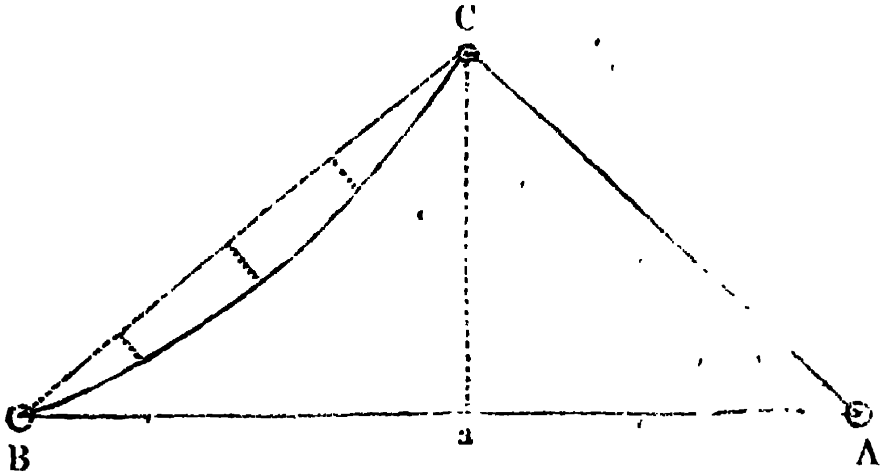
14000 No. 1.
22300 —— 2.
29500 —— 3.
23600 —— 4.
9400 —— 5.
10000 —— 6.
29000 —— 7.
44000 —— 8.
49400 —— 9.
41400 —— 10.
20150 —— 11.
11900 —— 12.
304650 sum.

1361100 } Whole double areas collected.
69160
154400
304650
2)1889310
9.44655
4
1.78620
40
31.44800

Area 9A. 1R. 31P.

4. Lay down a field, and find its area, from the following notes.

	C A	
	525	Perpen
	R. off C.	
	B C	
	846	0
	600	64
	400	85
	200	50
	000	0
	R. off B.	
	A B	
	1253	
	1000	
	586	a, the
Begin at	A. Range	W.



Triangle A B C.
1253 base.
525 per.
6265
2506
6265
657825

Insets taken on the line B C.

50
200
10000

50
85
135
200
27000

85
64
149
200
29800

246
64
984
1476
15744

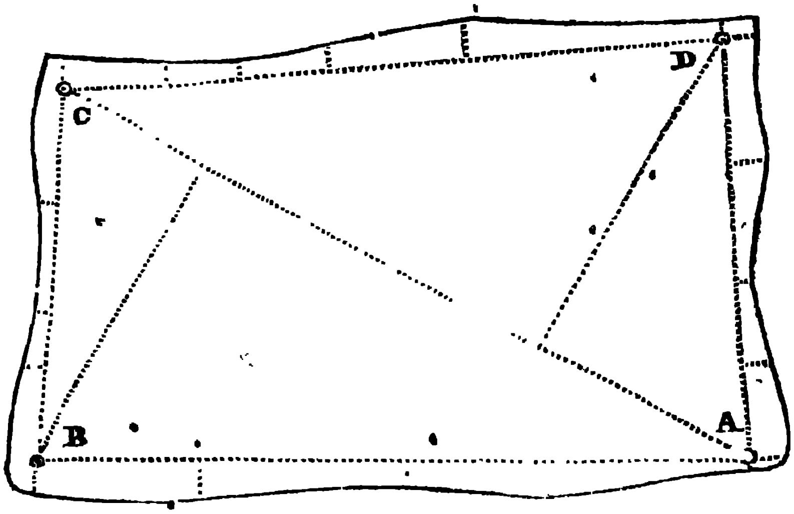
10000 27000 29800 15744	Double areas collected.
82544	

657825 Triangle A B C.
82544 Insets.
2)575281 Difference.
2.87640
4
3.50560
40
20.22400 Area. 2A. 3R. 20P.

5. Draw a plan of a field, and find its area, from the following notes.

	A C	Diag.
	1155	
	1000	
495	915	
	560	520
From	A, go	N. West.
To	the	Fence.
48	660	
53	630	to A
40	500	
25	380	
50	200	
62	000	
From	D, go	South

To	the	Fence.
40	1012	
42	950	to D.
54	600	
33	400	
12	260	
30	150	
65	000	
From	C, go	East.
To	the	Fence.
25	615	
35	550	to C.
30	400	
10	240	
22	150	
45	000	
From	B, go	North.
To	the	Fence.
33	1090	
45	1045	to B.
56	800	
40	500	
48	300	
30	000	
Begin at	A, and	go West.



Answer.

Double areas.

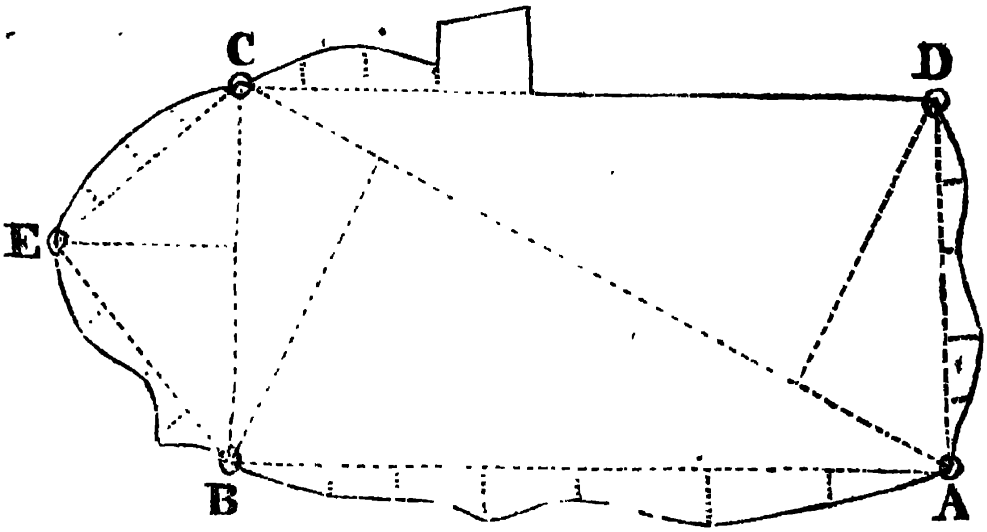
1172325 Trapezium A B C D.
98055 A B
32980 B C Offsets taken on the different lines.
81254 C D
58820 D A

Whole area 7A. 0R. 34¾P.

6. Lay down a field, and find its area, from the following dimensions.

	E B	
	442	0
	345	74
	256	25
	115	56
	000	0
	L. off E.	
	C E	
	387	0
	296	43
	200	59
	100	36
	000	
	L. off C.	
	A C	
	1294	Diag.
	1050	
B 530	1000	
	290	485 D
	R. off A.	
	D A	
	567	
0	458	
32	364	
67	235	
24	123	
43	000	
0	R. off D.	
	C D	
	1116	
	1000	
129	465	
80+30	310	
65	200	
42	100	
0	000	
	R. off C.	
	B C	
	584	Diag.
E 293	328	
	R. off B.	

	A B	
0	1173	
37	1000	
44	900	
78	750	
46	600	
85	400	
42	200	
0	000	
Begin at	A. Range	W.



Answer.

Double areas.
1313410 Trapezium A B C D.
171112 Triangle B E C.

111401	A B	Offsets taken on the different lines.
62395	C D	
37326	D A	
26805	C E	
33850	E B	

Whole area 8A. 3R. 5P.

7. It is required to lay down a field, and find its area, from the following notes.

To	the	Fence.
80	1121	
100	1025	to A
83	930	
70	800	
100	700	
130	600	
190	500	
140	400	
70	300	
50	200	
40	100	
0	000	
	R. off D.	
	B D.	Diag.
	1900	
	1300	823 A
	1000	
C 780	440	
	R. off B.	
	A B.	
0	1530	
66	1350	
73	1200	
85	1100	
94	1000	
73	900	
40	780	
70	630	
110	467	
76	300	
70	200	
69	100	
96	000	
Begin	at A;	and go West.

Answer.

Double areas.
3045700 Trapezium A B C D.
218592 Offsets taken on the line A B.
205555 Ditto on the line D A.
Whole area 17A. 1R. 15P.

8. Required the area and plan of a field, from the following dimensions.

	A D	
	1080	0
	1000	40
	950	60
	890	54
	820	38
	740	12
	650	10
	580	35
	535	60
	480	75
	420	65
	300	35
	220	30
	100	60
	50	70
	000	50
	L. off A.	
	C A	
	1170	Diag.
	920	540 B
525	225	
	R. off C.	
	B C	
0	1065	
25	1005	
35	946	
50	870	
40	830	
90	780	
115	715	
110	650	
80	625	
75	510	
55	440	
70	330	
65	250	
35	215	
48	150	
40	100	
60	50	
55	000	
	R. off B.	

To	the	Fence.
0	700	
40	645	to B.
55	570	
72	500	
68	450	
49	375	
42	300	
37	225	
53	170	
40	130	
50	50	to A.
52	000	
From the	Fence,	go North.

Answer.

Double areas.

1246050 Trapezium A B C D.
67710 Offsets taken on the line A B.
129829* Ditto on the line B C.
91210 Ditto on the line A D.
Whole area 7A. 2R. $27\frac{3}{4}$P.

9. Lay down a field, and find its area, from the following notes.

	E A
0	500
18	450
40	400
74	350
108	300
104	250
80	200
35	100
20	50
[illegible]	000
	R. off E.

	D E	
0	590	
20	550	
50	500	
130	450	
152	400	
110	350	
94	300	
110	250	
105	200	
80	150	
50	100	
25	50	
0	000	
Return	to	D.
	A C	
	1220	Diag.
B 550	915	
	700	524 D.
	R. off A.	
	D A	
	875	Diag.
E 322	490	
	R. off D.	
	C D	
0	750	
34	700	
55	650	
70	600	
84	550	
90	500	
95	450	
100	400	
75	350	
38	320	
44	200	
40	100	
30	50	
0	000	
	R. off C.	

	B C	
0	640	
18	600	
25	550	
30	500	
25	450	
35	430	
65	350	
60	320	
40	250	
10	140	
20	100	
40	000	
	R. off B.	
To	the	Fence.
65	1115	
70	1075	to B.
60	1000	
55	920	
60	868	
40	800	
20	750	
28	700	
65	600	
80	550	
73	400	
70	300	
34	200	
40	134	
23	100	
0	000	
Begin	at A.	Range W.

Answer.

Double areas.

1310280 Trapezium A B C D.
281750 Triangle A E D.
116056 A B
41020 B C
83180 C D Offsets taken on the different lines.
92400 D E
53650 E A
Whole area 9A. 3R. 22½P.

PROBLEM VII.

NARROW PIECES OF LAND.

The method frequently adopted, is to take breadths in different places, add all these breadths together, and divide their sum by their number, for a mean breadth; and this supposed mean breadth is multiplied by the length, for the area; but this process generally leads to very erroneous results, as the method of finding the mean breadth is void of truth.

If a piece of land taper regularly from one end to the other, you may take its breadth at each end; half the sum of these breadths, will be its mean breadth; and multiply this mean breadth by the length, for the area. But if it be irregular, you must take breadths in the widest and narrowest places, or at every particular curve, noting the place of each breadth, upon the chain-line. These breadths will divide it into trapezoids, which you must compute as before.

Note 1.—The breadths must be taken directly across the land to be measured, and therefore, if considerable, will require the use of the cross.

2.—If a piece of land be curved, or longer on one side than on the other, by measuring along the middle, you will obtain the true, or mean length.

3.—When several pieces of land, of various lengths, are contiguous to each other, it will generally be most expeditious to measure only one base-line, noting the point, where each piece begins and ends, perpendicularly to the line. In this case, be especially careful that no confusion take place in noting down the breadths of the respective pieces.

4.—Paring, reaping, &c. both in this and the foregoing problems, should be surveyed with a slack chain, in order, to obtain the measurement of the surface.

5.—It is best to take the first and last breadths of lands or ridges, about half a chain from each end, and account them as the end-breadths; because, in turning, the plough usually makes some of them appear either broader or narrower than they are in reality. It may also be observed that it is frequently necessary to take the breadths to half a link; for when the length is great, half a link in the breadth is too considerable to be neglected.

6.—If a narrow piece of land be very irregular, you may obtain its area most accurately, by measuring a base-line, in a convenient position; and, upon it, erecting perpendiculars to the boundaries, on each side.

7.—In surveying with the chain and cross, when the area only of any field or piece of ground is required, it is unnecessary to lay down the figure.

EXAMPLES.

1. Find the area of a tapering piece of land, whose length is 2562 links, and breadth at one end 126, and at the other 232 links.

```
      126 } breadths.
      232 }
   2)358  sum.
      179 mean
     2562 length.
      358
    1074
    895
   358
  4.58598
        4
  2.34392
       40
 13.75680   Area 4A. 2R. 14P
```

2. Find the area of a piece of land, which is broadest towards the middle, from the following dimensions.

BY THE TRUE METHOD.

2322	169
2000	
1056	215
1000	
000	125
Base.	Per.

$\left.\begin{array}{r}125\\215\end{array}\right\}$ per.
340 sum.
1056 base.
2040
170
34
359040

$\left.\begin{array}{r}215\\169\end{array}\right\}$ per.
384 sum.
1266 base.
2304
2304
768
384
486144

$\left.\begin{array}{r}359040\\486144\end{array}\right\}$ Double areas collected.
2)845184
4.22592
4
.90368
40
36.14720 Area 4A. 0R. 36P.

BY THE FALSE METHOD.

$\left.\begin{array}{r}125\\215\\169\end{array}\right\}$ breadths.
3)509
169.6 mean.

2322 length.
169.6 breadth.
13932
20898
13932
2322
3.938112
4
3.752448
40
30.097920

Here the area appears to be 3A. 3R. 30P., which is too little by 1R. 6P.

Again, the dimensions remaining as before, suppose the piece to be narrowest towards the middle; the area by the false method will be the same as already found.

BY THE TRUE METHOD.

2322	169
2000	
1056	125
1000	
000	215
Base.	Per.

$$\begin{array}{rl} 215 & \multirow{2}{*}{\} \text{ per.}} \\ 125 & \\ \hline 340 & \text{sum.} \\ 1056 & \text{base.} \\ \hline 2040 & \\ 170 & \\ 34 & \\ \hline 359040 & \end{array} \qquad \begin{array}{rl} 125 & \multirow{2}{*}{\} \text{ per.}} \\ 169 & \\ \hline 294 & \text{sum.} \\ 1266 & \text{base.} \\ \hline 1764 & \\ 1764 & \\ 588 & \\ 294 & \\ \hline 372204 & \end{array}$$

$$\begin{array}{rl} 359040 & \multirow{2}{*}{\} \text{ Double areas collected.}} \\ 372204 & \\ \hline 2)731244 & \\ \hline 3.65622 & \\ 4 & \\ \hline 2.62488 & \\ 40 & \\ \hline 24.99520 & \end{array}$$

The true area is 3A. 2R. 25P.; hence the false area is too much by 1R. 5P.

Lastly, the dimensions still continuing, suppose the breadth towards the middle to be greater than that at one end, and less than at the other; the false area will still be the same.

BY THE TRUE METHOD.

2322	125
2000	
1056	169
1000	
000	215
Base.	Per.

$$\begin{array}{rl} 215 & \multirow{2}{*}{\} \text{ per.}} \\ 169 & \\ \hline 384 & \text{sum.} \\ 1056 & \text{base.} \\ \hline 2304 & \\ 1920 & \\ 384 & \\ \hline 405504 & \end{array} \qquad \begin{array}{rl} 169 & \multirow{2}{*}{\} \text{ per}} \\ 125 & \\ \hline 294 & \text{sum.} \\ 1266 & \text{base.} \\ \hline 1764 & \\ 1764 & \\ 588 & \\ 294 & \\ \hline 372204 & \end{array}$$

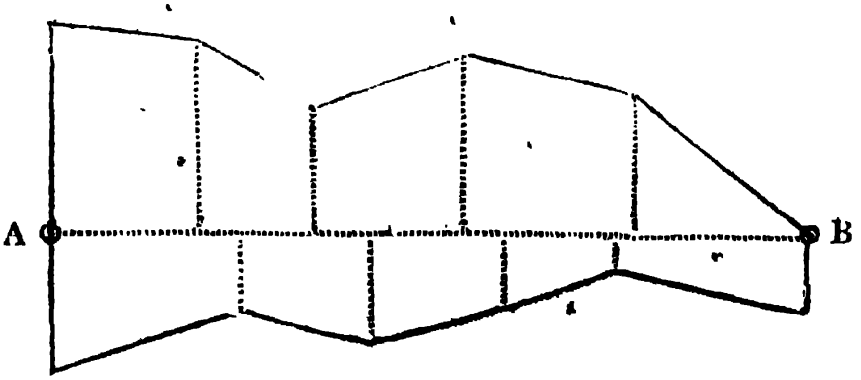
405504	Double areas
372204	collected.
2)777708	
3.88854	
4	
3.55416	
40	
22.16640	

The true area is 3A. 3R. 22P.; hence the false area is too much by 8P.

Thus we see the absurdity of a method which, however, has been long practised, and is not yet abolished.

3. Draw a plan of an irregular piece of land, and find its area from the following dimensions.

	A B	
0	1325	136
246	1015	
	987	58
	790	134
318	718	
	560	162
223	465	
	345	125
346	266	
372	000	246
From	A, go	East.



Answer.

Double areas.
361176 Offsets on the right.
684860 Ditto on the left.
2)1046036 sum.
5.23018 = 5A. 0R. $36\frac{3}{4}$P. the area required.

4. Find the area of five lands, from the following dimensions.

2378	185
2000	190
1700	194
1400	198
1000	200
700	195
400	189
000	185

Area 4A. 2R. $13\frac{1}{2}$P.

5. Required the area of six lands, from the following notes.

3422	189
3000	
2500	204
2000	
1800	226
1000	
800	191
000	165

Area 6A. 3R. 12P.

6. Find the area of seven lands, from the following dimensions

Note.—In calculating the area, the half-links must be treated as decimals.

2900	$99\frac{1}{2}$
2600	$98\frac{1}{2}$
2300	101
2000	$97\frac{1}{2}$
1900	$100\frac{1}{2}$
1600	102
1300	$99\frac{1}{2}$
1000	$101\frac{1}{2}$
900	100
600	$98\frac{1}{2}$
300	$100\frac{1}{2}$
000	100

Area 2A. 3R. $23\frac{3}{4}$P.

7. It is required to lay down a narrow piece of land, and find its area, from the following dimensions.

	A B	
250	1230	460
	1050	250
60	1000	
	918	300
25	800	
	690	235
0	500	
	440	108
0	300	
	100	216
150	000	130
From	A, go	N.

Answer.

Double areas.

552890 Offsets on the right.

140800 Ditto on the left.

Whole area 3A. 1R. 35P.

8. Lay down a field, and find its area, from the following notes.

	B C	
0	521	
70	400	
97	300	
99	200	
78	100	
0	000	
	R. off B.	
	A B	
0	1235	521 to C.
57	1100	430
114	900	323
177	650	245
207	500	219
232	350	240
252	200	275
268	000	360
From	A, go	North.

Answer.

Double areas.
763685 Offsets on the Right of A B.
414695 Do. on the Left of A B.
70270 Do. on the Line B C.

Area 6A. 0R. 38¾P.

PROBLEM VIII.

MERES AND WOODS.

WHEN you have a mere or wood to survey, by the help of your cross, fix four marks on its out side, in such a manner as to form a rectangle or square. Then measure each side of the rectangle or square, taking insets to the edge of the mere or wood, the area of which must be treated as directed in Note 2, Prob. VI.

If the opposite sides be not found equal, or very nearly so, your marks do not form four right angles; in which case, you must rectify your error.

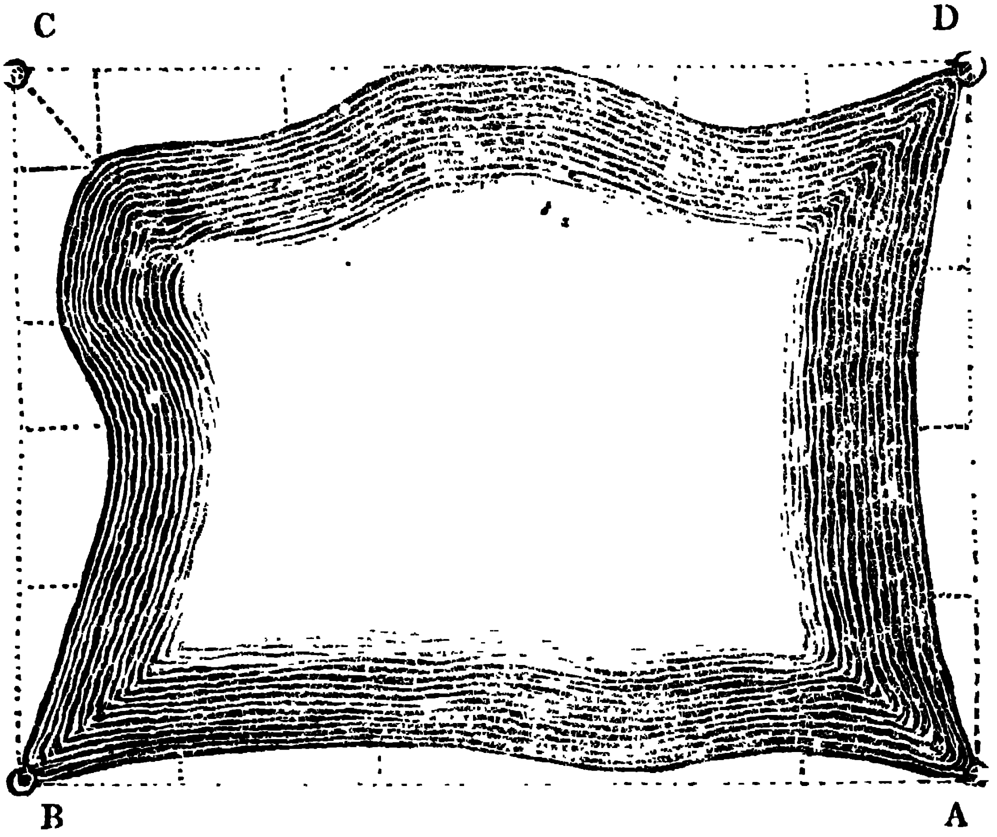
Note 1.—It is a more expeditious method to measure the four sides of a quadrilateral figure, having one right angle, paying no regard to the length of the sides. Then construct the figure by Part I. Prob. XIV.; and draw the longer diagonal, upon which let fall a perpendicular from each of the opposite angles. This diagonal, and these perpendiculars you must measure by the scale used in plotting.

2.—It sometimes happens, that the mere or wood is of a triangular form; in this case, the work may be very readily done, by measuring the three sides of a triangle, taking insets as before. After which construct the triangle, and from the opposite angle let fall a perpendicular upon the base, and proceed as before.

3.—By this problem you may measure fields into which you are not permitted to enter, or which contain obstructions.

EXAMPLES.

1. Let the following figure represent a mere; its area is required.



Having fixed four marks, A, B, C, and D, forming a rectangle; begin at A, and measure the line A B, taking the necessary insets, and entering them in your field-book. In the same manner proceed with the other three sides; and you will find noted the following dimensions.

A D	
1100	0
1000	
800	50
550	70
300	60
000	0
R. off D.	

	C D	
	1450	0
	1200	70
	1000	80
	820	0
	600	0
	400	95
	110	150
	000	0
	R. off C.	
	B C	
	1100	0
	950	110
	700	70
	550	142
	300	100
	000	0
	R. off B.	
	A B	
	1450	0
	1200	55
	1000	
	900	75
	550	32
	250	65
	000	0
Begin at	A. Range	W.

Answer.

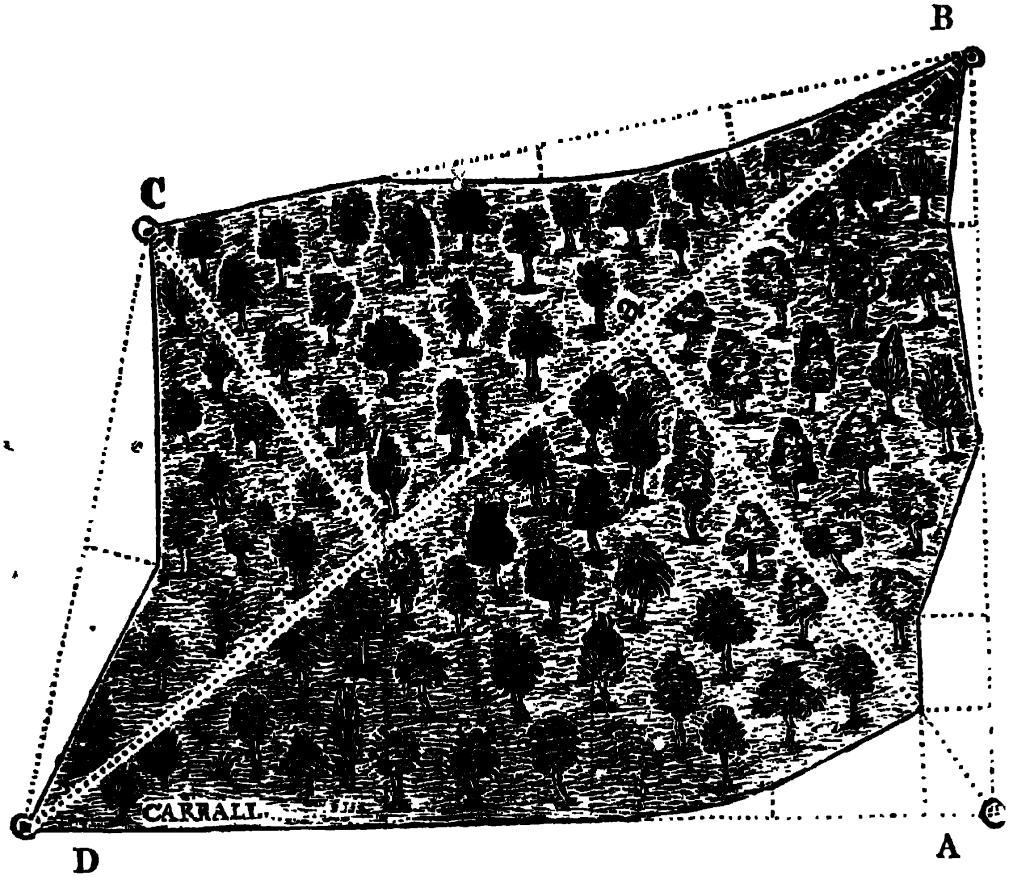
1595000 Area of the rectangle A B C D.

135550	A B	Double areas of the insets taken on the different lines.
183800	B C	
168450	C D	
95500	D A	

2)583300
291650 Area of the whole insets.
13.03350 Ditto of the mere.
4
.13400
40
5.36000

Area 13A. 0R. 5P.

2. Let the following figure represent a wood; its area is required.



Set up your cross at A, and let your assistant fix the marks B and D, so that the angle at A may be a right angle; and measure the line A B, taking insets as before. Then fix the mark C, as most convenient; measure the other three lines, and you will find in your field-book the following notes.

	D A
0	1550
160	1440
50	1200
	1000
0	900
	L. off D.
	C D
0	950
120	500
0	000
	L. off C.

	B C	
	1340	
0	1050	
	1000	
50	700	
60	400	
0	000	
	L. off B.	
	A B	
0	1150	
	1000	
50	900	
0	550	
100	300	
110	160	
0	000	
Begin at	A. Range	N.

Answer.

Having constructed the figure, you will find the diagonal B D to measure 1930, the perpendicular A a 923, and C a 605 links.

Double areas.

2949040 Trapezium A B C D.

102000	A B	Insets taken on the different lines.
74500	B C	
114000	C D	
83000	D A	

373500 Whole Insets.

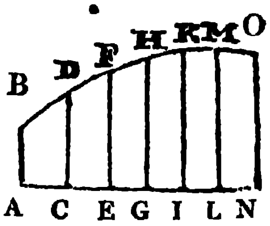
2575540 Wood. Area 12A. 3R. 20P.

PROBLEM IX.

To find the Area of a Segment of a Circle, or any other Curvilineal Figure, by means of Equidistant Ordinates.

RULE.

If a right line A N be divided into any even number of equal parts A C, C E, E G, &c.; and at the points of division be erected perpendicular ordinates A B, C D, E F, &c. terminated by any curve B D F, &c.; and if A be put for the sum of the extreme or first and last ordinates, A B, N O;



B for the sum of the even ordinates C D, G H, L M, &c.; viz. the second, fourth, sixth, &c.; and C for the sum of all the rest E F, I K, &c.; viz. the third, fifth &c., or the odd ordinates, wanting the first and last; then the common distance A C, or C E, &c. of the ordinates, being multiplied by the sum arising from the addition of A, four times B, and two times C; one-third of the product will be the area A B O N, very nearly; that is, $\frac{A + 4B + 2C}{3} \times D =$ the area, putting $D = A\,C$, the common distance of the ordinates.

Note.—The foregoing rule being expressed in an algebraic form, is seldom properly understood by learners; but the following one may be easily comprehended and committed to memory.

RULE.

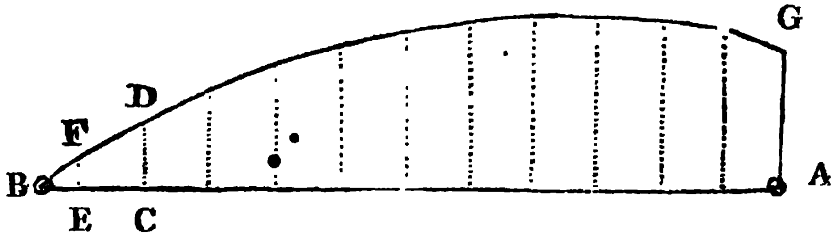
To the sum of the first and last ordinates, add four times the sum of all the even ordinates, and twice the sum of all the odd ordinates, not including the first and last; multiply this sum by the common distance of the ordinates, divide the product by 3, and the quotient will be the area required.

Note.—The length of the base must be ascertained before you begin to take the ordinates, in order that you may divide it into an even number of equal parts; or you may take the dimensions without doing this, and find the areas of the pieces at the end, by the rules for triangles and trapezoids, which being added to that part of the figure computed by equidistant ordinates, will give the whole area. See the following example.

EXAMPLES.

1. Required the plan and area of a piece of land, measured by equidistant ordinates, from the following notes.

	A B	
	1167	0
	1100	44 E F
	1000	97 C D
	900	139
	800	175
	700	206
	600	230
	500	248
	400	260
	300	264
	200	268
	100	262
	000	252
Begin	at A, and	go West.



The first and last ordinates.

252 The first ordinate A G.
97 The last ordinate C D.
349 Sum.

The even ordinates.

262 Second.
264 Fourth.
248 Sixth.
206 Eighth.
139 Tenth.
1119 Sum.
4
4476 Four times the sum.

The odd ordinates.

268	Third.
260	Fifth.
230	Seventh.
175	Ninth.
933	Sum.
2	
1866	Twice the sum.

349	The first and last ordinates.
4476	Four times the sum, &c.
1866	Twice the sum, &c.
6691	Sum total.
100	The common distance.
3)669100	
223033	The area of the figure A C D G.

Trapezoid C E F D	Triangle E B F.
97	67
44	44
141	268
100	268
14100	2948

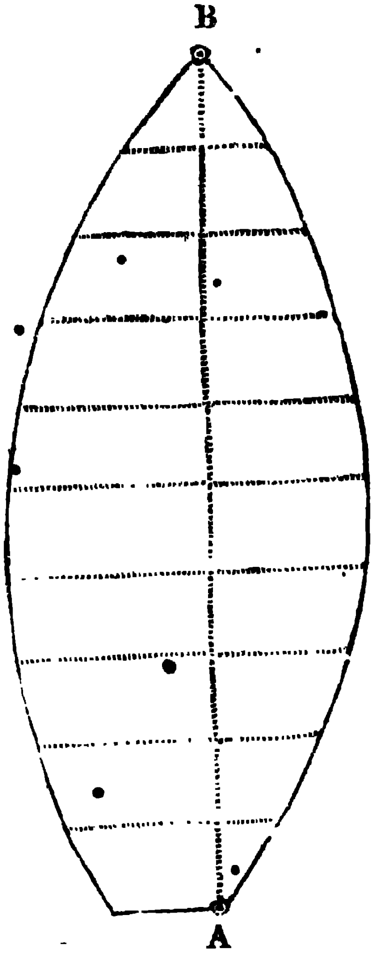
Double areas.

14100	Trapezoid C E F D.
2948	Triangle E B F.
2)17048	Sum.
8524	The area of the figure C B D.
223033	Ditto of the figure A C D G.
2.31557	Sum.
4	
1.26228	
40	
10.49120	

Hence the area of the whole figure A C E B F D G A, is 2A. 1R. 10½P. nearly.

2. Lay down a piece of ground, and find its area from the following equidistant ordinates.

	A B	
0	1000	0
85	900	75
150	800	125
200	700	160
230	600	180
247	500	185
250	400	177
240	300	157
216	200	125
180	100	73
130	000	0
Begin	at A, and	go N.



The first and last ordinates.

130 The first ordinate.
000 The last ditto.
130 Sum.

The even ordinates.

180 + 73 = 253 Second.
240 + 157 = 397 Fourth.
247 + 185 = 432 Sixth.
200 + 160 = 360 Eighth.
85 + 75 = 160 Tenth.
1602 Sum.

6408 Four times the sum.

The odd ordinates.

216 + 125 = 341 Third.
250 + 177 = 427 Fifth.
230 + 180 = 410 Seventh.
150 + 125 = 275 Ninth.
1453 Sum.
2
2906 Twice the sum.

130 The first and last ordinates.
6408 Four times the sum, &c.
2906 Twice the sum, &c.
9444 Sum total.
100 The common distance.
3)944400
3.14800 Area in square links.
4
.59200
40
23.68000 Area 3A. 0R. $23\frac{1}{2}$P.

3. Required the plan and area of a piece of ground, from the following equidistant ordinates.

	A B	
220	1200	
234	1100	
245	1000	
250	900	
246	800	
235	700	
221	600	
200	500	
176	400	
140	300	
100	200	
55	100	
0	000	
Begin	at A, and	range E.

Answer.

220 The first and last ordinates.
4456 Four times the sum, &c.
1976 Twice the sum, &c.
6652 Sum total.
100 The common distance.
3)665200
2.21733 Area in square links.
4
.86932
40
34.77280 Area 2A. 0R. 34$\frac{3}{4}$P.

4. Find the area of 4 lands, measured by equidistant ordinates from the following notes.

182	1290	70
183	1200	101
178	1100	115
189	1000	112
190	900	96
187	800	98
179	700	95
150	600	100
182	500	120
185	400	110
180	300	131
160	200	133
170	100	137
188	000	130

Answer.

602 The first and last ordinates.
7092 Four times the sum, &c.
2848 Twice the sum, &c.
10542 Sum total.
100 The common distance.
3)1054200
351400
24120 Trapezoid at the end.
3.75520 Area in square links.
4
3.02080
40
0.83200 Area 3A. 3R. $0\frac{3}{4}$P.

5. Find the area of 6 lands, by equidistant ordinates, from the following dimensions.

147	3090
153	3000
152	2700
150	2400
149	2100
147	1800
144	1500
142	1200
143	900
148	600
146	300
145	000

Answer.

298 The first and last ordinates.
2936 Four times the sum, &c.
1174 Twice the sum, &c.
4408 Sum total.
300 The common distance.
3)1322400
4.40800
13500 Trapezoid at the end.
4.54300 Area in square links.
4
2.17200
40
6.88000 Area 4A. 2R. $6\frac{3}{4}$P.

6. Required the plan and area of a piece of ground from the following equidistant ordinates.

	A B	
236	1200	180
170	1100	220
126	1000	246
90	900	265
67	800	270
55	700	269
57	600	260
66	500	243
87	400	215
120	300	180
170	200	134
232	100	65
327	000	0
Begin	at A, and	go W.

Answer.

743 The first and last ordinates.
7900 Four times the sum, &c.
3264 Twice the sum, &c.
11907 Sum total.
100 The common distance.
3)1190700
3.96900 Area in square links.
4
3.87600
40
35.04000 Area 3A. 3R. 35P.

7. Required the plan and area of a field from the following equidistant ordinates.

	A B	
217	1096	202
187	1000	150
150	900	112
125	800	84
107	700	66
98	600	58
95	500	57
100	400	65
114	300	80
130	200	110
167	100	148
190	000	200
Begin	at A, and	go N.

Answer.

727 The first and last ordinates.
4384 Four times the sum, &c.
1540 Twice the sum, &c.
6651 Sum total.
100 The common distance.
3)665100
221700
36288 Trapezoid at the end.
2.57988 Area in square links.
4
2.31952
40
12.78080 Area 2A. 2R. 12$\frac{3}{4}$P.

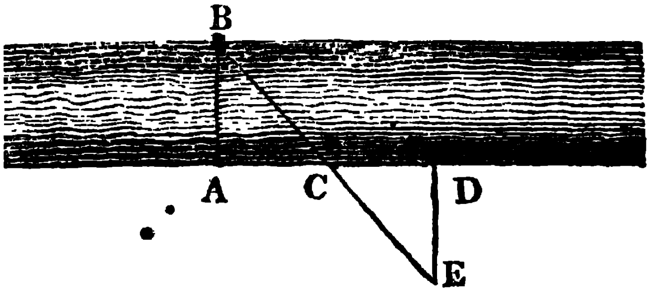
Note.—Whenever the rule given in this Problem can be applied, it will be found more easy, expeditious, and accurate, in finding the areas of offsets, and of narrow pieces of land, than the rules for triangles and trapezoids. (See my Mensuration, page 274.)

PROBLEM X.

TO FIND THE BREADTH OF A RIVER.

EXAMPLE.

Let the following figure represent a river, the breadth of which is required.



Fix upon any object B, close by the edge of the river, on the side opposite to which you stand. By the help of your cross, make A D perpendicular to A B; also make A C = C D, and erect the perpendicular D E; and when you have arrived at the point E, in a direct line with C B, the distance D E will be = A B, the breadth of the river; for by Theo. 1, Part I, the angle A C B = D C E, and as A C = C D, and the angles A and D right angles, it is evident that the triangles A B C, C D E are not only similar but equal.

Note 1.—The distance between A and the edge of the river, must be deduced from D E, when it is not convenient to fix A close by the river's edge.

2.—This Problem may also be well applied in measuring the distance of any inaccessible object; for let A C equal 8, C D equal 2, and D E equal 10 chains; then, by similar triangles, as C D : D E :: A C : A B; that is, as 2 : 10 :: 8 : 40 chains = A B. (See Theo. 11, Part I.)

PROBLEM XI.

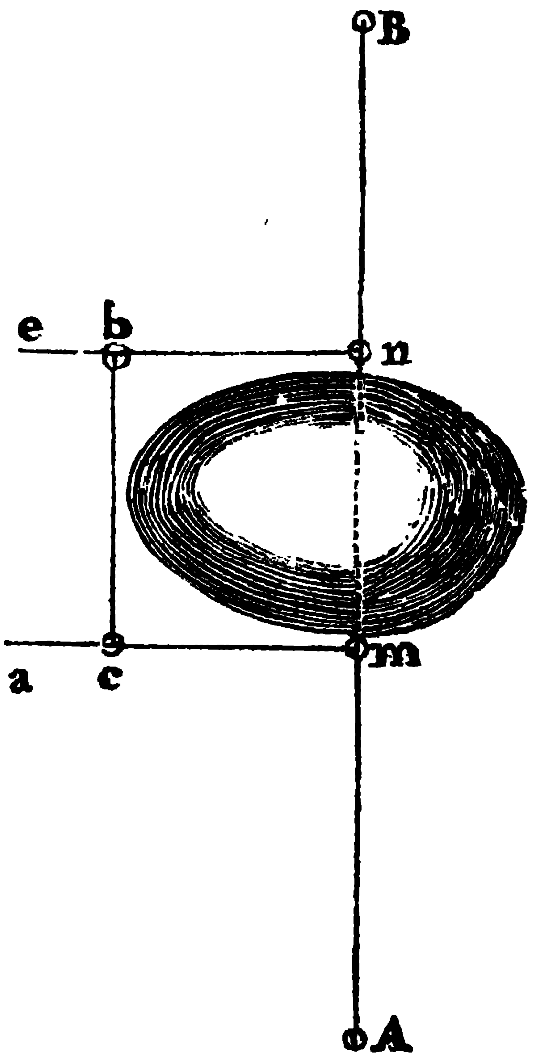
LINES UPON WHICH THERE ARE IMPEDIMENTS NOT OBSTRUCTING THE SIGHT.

EXAMPLE.

Suppose m n, to represent a deep pit or water, and A and B two objects, the direct distance of which is required.

At the verge of the impediment, having fixed the mark m, in a right line with A and B; measure from A to m; and at m, by the help of your cross, erect the perpendicular m a, which measure to the outside of the interposed obstruction, as at c. Then on the other side, as at n, in a line with A and B, erect the perpendicular n e; and make n b equal to m c.

Measure b c, which will be equal to m n; and from n, measure the distance n B; then b c, added to A m and n B, will give the whole distance A B.



PROBLEM XII.

LINES UPON WHICH THERE ARE IMPEDIMENTS OBSTRUCTING THE SIGHT.

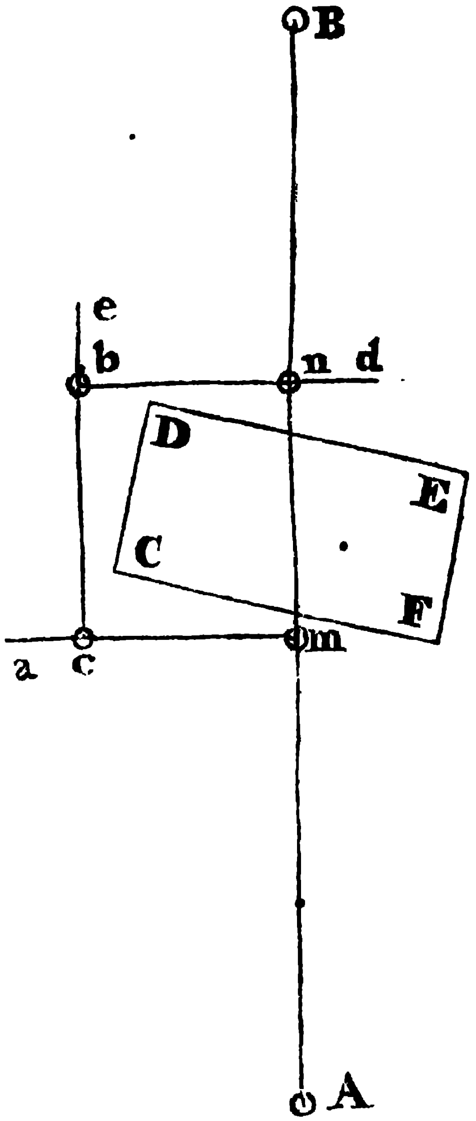
EXAMPLE.

Suppose C D E F to represent the base of a building, which obstructs the sight, and through which it is necessary that a straight line should pass from an object at A.

Measure from A to m; at m, erect the perpendicular m a, which measure until you are clear of the impediment, as at c.

Erect the perpendicular c e, which measure until you are beyond the building, as at b. Erect the perpendicular b d; and make b n, equal to m c, at which point you will be in a direct line with m A. Erect the perpendicular n B, which measure; then b c, added to A m and n B, will give the whole distance A B.

Note.—The last two problems are very useful when you meet with impediments upon a base-line.



LAND-SURVEYING.

Part the Fourth.

The Method of Surveying with the Chain only; and of measuring Meres, Woods, Distances, Lines upon which there are Impediments, and Hilly Ground.

MISCELLANEOUS INSTRUCTIONS.

The method of surveying with the chain only, is adopted by most Practical Surveyors, and is certainly preferable to that by the chain and cross; because it is not only always as accurate, but generally more expeditious.

Whatever be the form of the field or ground to be surveyed, you must measure as many lines as will enable you to plot it with accuracy. The plan being drawn, you may then divide the figure into trapeziums, triangles, &c.; and measure the diagonals, perpendiculars, &c. with your plotting-scale.

It is better, however, to divide small pieces, and single fields, into trapeziums and triangles, by measuring the diagonals and bases during the survey; so that to find the area, you will have only the perpendiculars to measure with the scale.

You must also measure, in some convenient direction, a proof-line to each trapezium and triangle.

Note 1.—The offsets must be treated according to the directions in Part III. Prob. 6. Or, you may reduce the crooked sides to straight ones, by including as much of what does not belong to the field under your survey, as you exclude of what does, in the following manner. Apply to the crooked line in question, the straight edge of a clear piece of lantern-horn, so that the small parts cut off by it, from the crooked figure, may be equal to those which are taken in; (of this equality you will presently be able to judge very correctly, by a little practice ;) then, with a pencil, draw a line by the edge of the horn. The sides being thus successively straightened, the content may be easily found.

2.—A slender bow of cane or whale-bone, strung with a silk thread, may be substituted for the horn, The thread must be applied to the crooked fence, and two marks made, by which a straight line must be drawn.

3.—The sides may also be straightened by a parallel ruler ; but the operation is generally tedious, and must be performed with the greatest care, or it will not be more correct than the foregoing method.

4.—When the three sides of a triangle are given, the area may be found as follows. From half the sum of the three sides subtract each side severally ; multiply the half sum and the three remainders continually together, and the square root of the last product will be the area required. This method is too prolix, except in particular cases ; the operation may, however, be considerably simplified, by performing the multiplication and evolution by Logarithms.

PROBLEM I.

TRIANGULAR FIELDS.

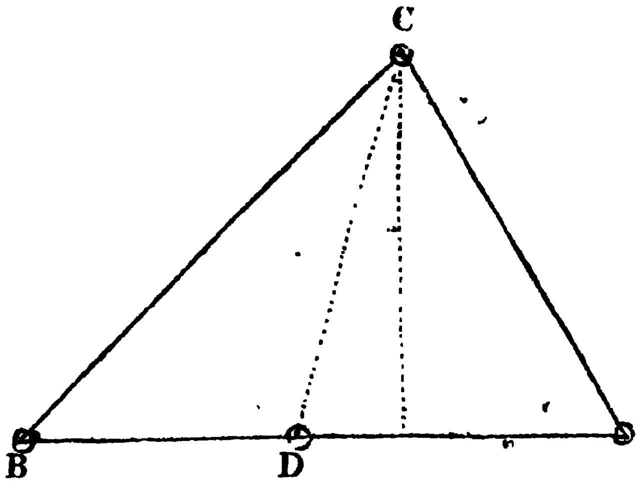
When you have a triangular field to survey, begin at the most convenient corner, and measure each side; and, while measuring any one of the sides, leave a mark in some situation on the chain-line, that the distance between it and the opposite angle being measured, may be a proof-line.

Or, leave marks upon any two of the chain-lines, and the distance between them will prove your work.

EXAMPLES.

1. It is required to construct a figure, and find its area, from the following notes.

	D C	
	913	proof-line.
	Return to D.	
	C A	
	1029	
	R. off C.	
	B C	
	1275	
	1000	
	R. off B.	
	A B	
	1462	
	1000	
	800	D, station.
Begin at	A. Range	W.



Having constructed the figure, you will find the line D C to measure 913 links, as in the field-book; hence, you may conclude there is no error committed in taking, or setting down the dimensions.

Note 1.—If your proof-line upon the plan does not agree, or nearly so, with that taken in the field, you may be assured that some error has been committed; you must, therefore, repeat the survey in order to discover it.

2.—When land is level, and the lines are well driven, and not very long, you will generally find them to meet correctly.

TO FIND THE PERPENDICULAR.

Vide Part I. Prob. 6.

Or, if you make use of a plotting-scale, lay it across the base in such a manner, that the line which goes across the scale, may coincide with it, the edge of the scale at the same time touching the opposite angle; by that edge draw a line from the base to the opposite angle; this line, or perpendicular C a, in the present case, you will find to be 878 links.

$$\begin{array}{rl}
1462 & \text{base.} \\
878 & \text{per.} \\
\hline
11696 & \\
10234 & \\
11696 & \\
2)1283636 & \\
\hline
6.41818 & \\
4 & \\
\hline
1.67272 & \\
40 & \\
\hline
26.90880 & \quad \text{Area } 6\text{A. } 1\text{R. } 27\text{P.}
\end{array}$$

COMPUTATION OF THE AREA FROM THE THREE SIDES.

Here $\frac{1462+1275+1029}{2}=\frac{3766}{2}=1883$, half the sum of the three sides. Then $1883-1462=421$, the first remainder; $1883-1275=608$, the second remainder; and $1883-1029=854$, the third remainder; whence $\sqrt{1883\times 421\times 608\times 854}=\sqrt{411617533376}=641574$ square links, the area, equal to 6 acres, 1 rood, and 26½ perches, nearly the same as before.

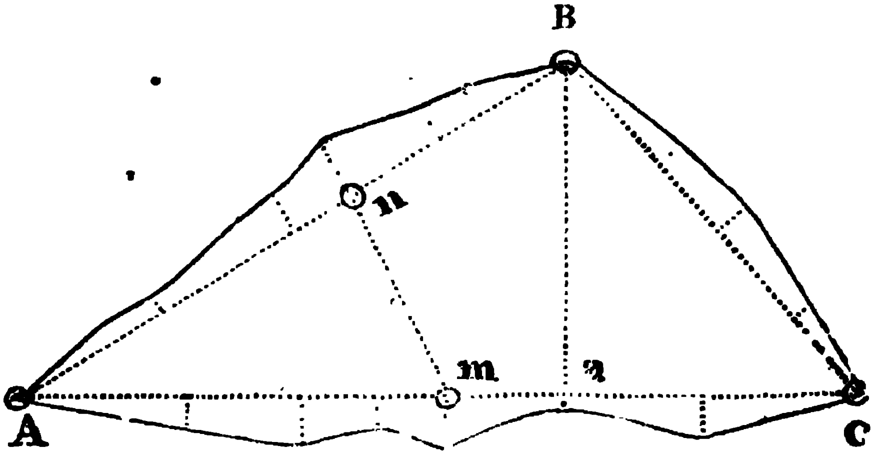
THE SAME BY LOGARITHMS.

The log. of	1883	= 3.2748503
———	421	= 2.6242821
———	608	= 2.7839036
———	854	= 2.9314579
Divide by the index of the root		2)11.6144939
The quotient is the log. of 641574, the area		5.8072469

2. It is required to construct a figure, and find its area, from the following notes.

	C A	
0	1252	
37	1000	
69	824	
45	716	
72	610	m, station for a proof-line, which goes to n, and measures 352 links.
15	424	
55	212	
0	000	
	R. off C.	
	B C	
0	683	
40	536	
64	354	
49	229	
0	000	
	R. off B.	
	A B	
0	973	
48	745	
76	600	n, station for a proof-line.
56	495	
25	256	
0	000	
Begin at	A. Range	N. E.

COMPUTATION OF THE AREA BY OFFSETS, &c.



Having constructed the figure, you will find the line m n to measure 352 links, as in the field-book. You will also find the perpendicular B a, to be 528 links.

Triangle A B C.

1252 base.
528 per.
10016
2504
6260
661056

Offsets taken on the line A B.

256
25
1280
512
6400

25
56
81
239
729
243
162
19359

56
76
132
105
660
132
13860

76
48
124
145
620
496
124
17980

228
48
1824
912
10944

6400
19359
13860
17980
10944
} Double areas collected
68543 sum.

Offsets taken on the line B C.

229
49
2061
916
11221

49
64
113
125
565
226
113
14125

64
40
104
182
208
832
104
18928

147
40
5880

11221
14125
18928
5880
Double areas collected
50154 sum.

Offsets taken on the line C A.

212
55
1060
1060
11660

55
15
70
212
14840

15
72
87
186
522
696
87
16182

72
45
117
106
702
117
12402

45
69
114
108
912
114
12312

69
37
106
176
636
742
106
18656

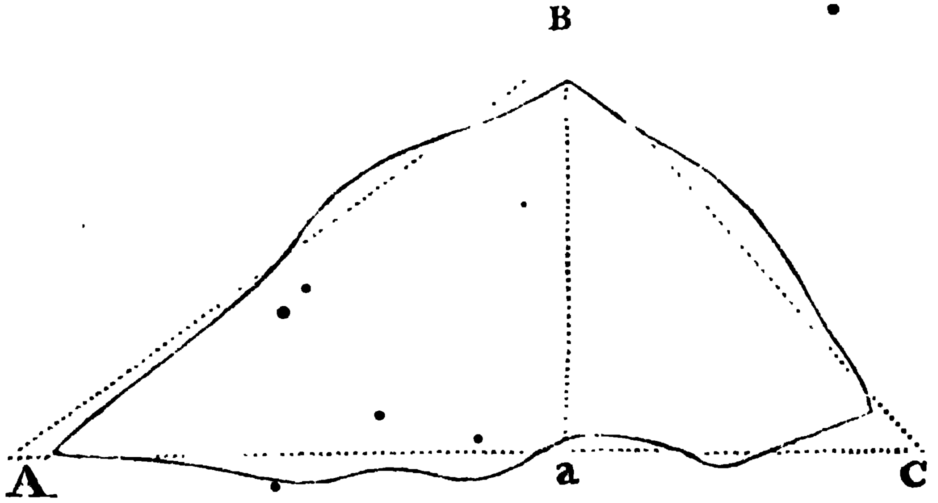
252
37
1764
756
9324

11660
14840
16182
12402
12312
18656
9324
Double areas collected.
95376 sum.

$$\left.\begin{array}{r}661056\\68543\\50154\\95376\end{array}\right\}\text{Whole double areas collected.}$$

$$\begin{array}{r}2)\overline{875129}\\\hline 4.37564\\4\\\hline 1.50256\\40\\\hline 20.10240\end{array}\quad\text{Area 4A. 1R. 20P.}$$

COMPUTATION OF THE AREA BY REDUCING THE CROOKED SIDES TO STRAIGHT ONES: GENERALLY CALLED "CASTING."



Having constructed the figure as before, and taken out the chain-lines; draw the three dotted lines A B, B C, and C A, in such a manner, that the parts included may be equal to those excluded, as nearly as your eye can judge. Then the base A C being measured, will be found = 1390 links; and the perpendicular B a = 630 links.

$$\begin{array}{rl}1390 & \text{base.}\\630 & \text{per.}\\\hline 41700 & \\8340 & \\\hline 2)\overline{875700} & \\\hline 4.37850 & \\4 & \\\hline 1.51400 & \\40 & \\\hline 20.56000 & \text{Area 4A. 1R. 20P.}\end{array}$$

Note.—Although the method of finding the area by Casting (which depends entirely upon the accuracy of the eye) is adopted by most Practical Surveyors; it is certainly less correct than that by Offsets, &c. A learner, therefore, ought to practise both, until he can habitually come very near to the truth by the former.

3. Lay down a field, and find its area, from the following notes.

	B D	
	760	proof-line.
Return	to	B.
	D A	
	1035	
	R. off D.	
	C D	
61	1145	
55	1100	
12	1000	
72	950	
119	900	
80	850	
61	800	
59	750	
110	700	
179	600	
210	550	
215	500	
212	450	
180	400	
159	350	
142	300	
165	250	
173	200	
161	150	
126	100	
65	50	
0	000	
	R. off C.	
	A C	
	1590	
B	890	
Begin at	A, and	Range W.

Answer.

Having constructed the figure, you will find the perpendicular D a, upon the base A C, to measure 740 links.

Double areas.

1176600 Triangle A C D.

275770 Offsets taken on the line C D.

Area 7A. 1R. 1¾P.

4. Lay down a field, and find its area, from the following dimensions.

	D B	
	575	proof-line.
Return	to	D.
	C A	
	1320	
D	600	
	R. off C.	
	B C	
0	880	
31	800	
73	750	
95	700	
58	600	
60	550	
95	500	
60	380	
63	250	
60	200	
45	100	
55	000	
	R. off B.	
To	the	fence
30	930	
17	875	to B.
48	800	
65	700	
74	600	
65	500	
58	400	
55	300	
30	200	
17	100	
0	000	
Begin	at A, and	Range N. E.

Answer.

Having constructed the figure, you will find the perpendicular B a, upon the base A C, to measure 573 links.

Double areas.
756360 Triangle A B C.
85060 Offsets taken on the line A B.
106270 Ditto on the line B C.

Area 4A. 2R. 38P.

5. Lay down a field, and find its area, from the following notes.

	D C	
	596	proof-line.
Return	to	D.
	C A	
	1080	
6	1000	
50	900	
110	800	
130	700	D, station for
145	620	a proof-line.
106	550	
65	500	
30	450	
16	410	
36	350	
54	300	
70	250	
74	200	
86	150	
70	100	
46	50	
0	000	
	R. off C.	

		B C	
	0	848	
	30	800	
	60	750	
	80	700	
	70	650	
	48	600	
	20	520	
	46	450	
	90	380	
	100	330	
	110	270	
	70	200	
	40	150	
	50	100	
	45	000	
		R. off B.	
	To	the fence.	
	50	800	
	45	755	to B.
	30	700	
	40	650	
	75	600	
Brook 50 links in breadth.	130	550	
	170	500	
	156	450	
	135	400	
	50	350	
	24	300	
	66	250	
	80	200	
	40	150	
	20	100	
	23	50	
	0	000	
	From	A, Range	N. E.

Answer.

Having laid down the figure, you will find the perpendicular B a, upon the base A C, to measure 587 links.

Double areas.

633960 Triangle A B C.

110800 Offsets taken on the line A B.

100120 Ditto on the line B C.

149310 Ditto on the line C A.

Area 4A. 3R. 35¼P.

PROBLEM II.

FIFLDS IN THE FORM OF A TRAPEZIUM.

When you have a trapezium to survey, measure each side, and both the diagonals, one of which will enable you to construct the figure, and the other will serve as a proof-line: or, you may measure the longer diagonal, and a proof-line in any other direction most convenient.

Note 1.—From various obstructions it is sometimes impossible to take either of the diagonals; in such cases, you must measure tie-lines across the angles of the field, at any convenient distance (not less than two chains) from the corners. These you will find sufficient for constructing the figure, and for proofs. Or, you may take an external angle, or angles, as directed in Problem IV.

2.—When the lines, including the angle you intend to take with the chain, are of a considerable length, it will be necessary to measure more than two chains from the angular point, before you take the chord-line; because a small inaccuracy in constructing the figure, when the angular distance is short, will throw the lines, when far produced, considerably out of their true position. It sometimes happens, however, in consequence of obstructions, that it is impossible to measure the chord-line at a greater distance from the angular point, than one or two chains. In such cases, multiply both the chord-line and angular distance by 2, 3, 4, or any larger number, as circumstances may require; and use the products resulting, in laying down the figure.

3.—When the measurement of the surface is required, for reaping, &c. you must let the chain touch the sides of the lands, in all places where you measure across them. If you do not measure across the lands, but along the headland; then you must add as many links to the length of the chain-line, as will make it equal to one measured across the lands, parallel to and near the headland.

You may easily ascertain what number of links you ought to add, by stretching the chain across the lands, and putting down an arrow at each end; after which, leave hold of one of the ends, and you will observe it recede from the arrow. The number of links, by which it falls short of its former position, you must add to each chain. Some lands you will find so low, that nothing need be added to the chain-line; and some will require a link to four, three, two, or even (where the lands are very high) a link or more to one chain.

To this method some may object; but, when the lands are high, if the lines measured along the headlands be not lengthened the perpendiculars will obviously measure less than they ought to do; consequently, the horizontal measure will be returned, instead of the measure of the surface.

In the opinion of others, the diagonal, measured with a slack chain, will give the measure of the surface; but, in this case, the perpendiculars will evidently be shorter than they would have been, if the diagonal had been measured with a tense chain; consequently, the measurement will be the same, or very nearly the same, whether the diagonal be measured with a tense or slack chain, unless the headland lines be lengthened.

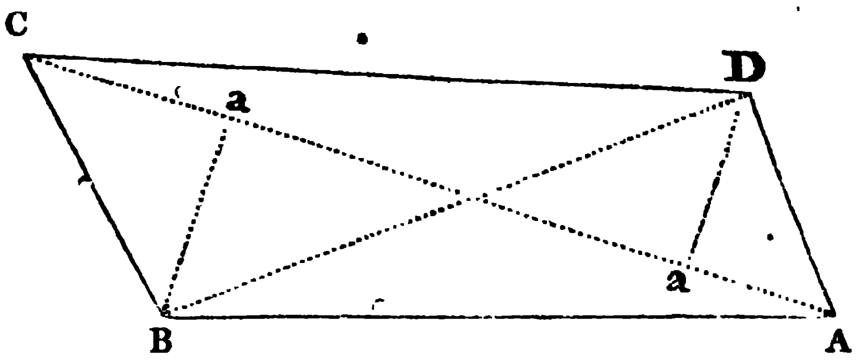
4.—If two or three persons measure the same piece of land separately, or even if one person measure the same piece twice over, there will generally be a difference between the measurements; this difference, however, in small pieces, should scarcely ever exceed four or five perches.

5.—When land, crops of corn, &c. are bought and sold, the buyer and seller commonly choose each a surveyor; and in their measurements it occasionally happens that there exists a considerable difference. In this case, the best method, perhaps, of adjusting the dispute is, that the two surveyors meet, and jointly remeasure the land. If this fail, it only remains that the buyer and seller jointly choose an experienced surveyor, as an umpire, by whose decision the law will compel the parties to abide.

EXAMPLES.

1. It is required to construct a figure, and find its area, from the following notes.

	B D	
	1400	Diag.
	1000	
	Return	to B.
	A C	
	1916	Diag.
	1000	
	R. off A.	
	D A	
	558	
	R. off D.	
	C D	
	1626	
	1000	
	R. off C.	
	B C	
	689	
	R. off B.	
	A B	
	1492	
	1000	
Begin at	A. Range	W.



Having constructed the figure, lay your scale from B to D; and if you find it exactly 1400 links, as in the field-book; you may then measure the perpendicular B a = 468 links; and the perpendicular D a = 432 links; from which you will readily compute the area required.

468 } per.
432 }
900 sum.
1916 diag.
2)1724400
8.62200
4
2.48800
40
19.52000 Area 8A. 2R. 19P.

BY THE FALSE METHOD.

Remarked in Part III. Prob. 4. Note 4.

1492 = A B
1626 = C D
2)3118
1559 mean length.

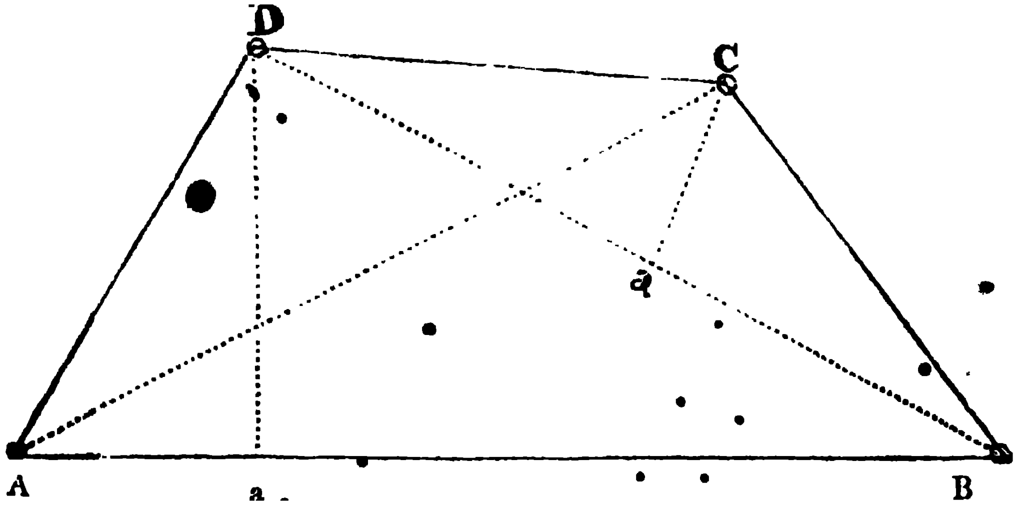
689 = B C
558 = D A
2)1247
623 mean breadth.

1559
623
4677
3118
9354
9.71257
4
2.85028
40
34.01120

Here the area is found to be 9A. 2R. 34P.; which is too much by 1A. 0R. 15P.; but the more nearly a trapezium approaches to a square, or rectangle, the less will be the error.

2. Required the area of a field, from the following notes.

	D B	
	1365	Diag.
	1000	
	Return	to D.
	A C	
	1288	Diag.
	1000	
	L. off A.	
	D A	
	750	
	L. off D.	
	C D	
	765	
	L. off C.	
	B C	
	720	
	L. off B.	
	A B	
	1600	
	1000	
Begin at	A. Range.	E.



Having constructed the figure, you will find that in consequence of the length of the side A B, a perpendicular from the angle A to the diagonal D B, cannot be taken; you must, therefore, let fall the perpendicular D a, from the angle D to the side A B, which you will find = 638 links. The perpendicular C a will be found = 294 links.

Triangle A B D.	Triangle B C D
1600 base.	1365 base.
638 per.	294 per.
12800	5460
48	12285
96	2730
1020800	401310

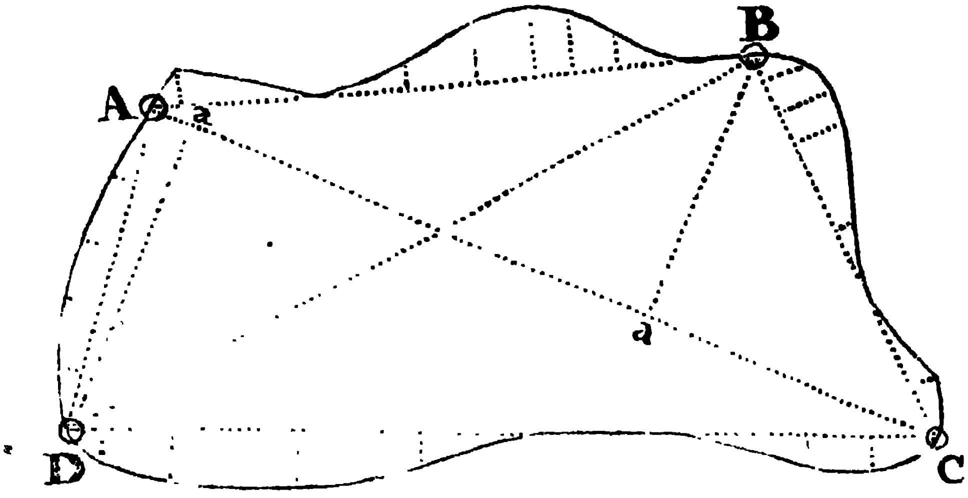
1020800 } Double areas
401310 } collected.
2)1422110
7.11055
4
.44220
40
17.68800 Area 7A. 0R. 18P.

3. It is required to find the area of a field, from the following notes.

	B D	
	1236	Diag.
	1000	
	Return to B.	
	A C	
	1326	Diag.
	1000	
	R. off A.	
	D A	
0	515	
28	400	
50	300	
65	200	
33	100	
0	000	
	R. off D.	

	C D	
0	1375	
50	1300	
75	1200	
84	1000	
52	800	
0	652	
0	356	
44	200	
50	100	
0	000	
	R. off C.	
	B C	
0	664	
25	570	
0	483	
0	378	
32	300	
72	150	
85	100	
60	50	
0	000	
	R. off B.	
	A B	
	946	
0	784	
50	725	
93	650	
106	600	
75	500	
32	400	
0	335	
0	242	
50	40	
0	000	
Begin at	A. Range.	E.

BY OFFSETS, &c.



Having constructed the figure, you will find the perpendicular D a = 512, and the perpendicular B a = 446 links.

Trapezium A B C D.

```
    512 } per.
    446 }
    ———
    958 sum.
   1326 diag.
   ————
   5748
  1916
 2874
 958
———————
1270308
```

Offsets taken on the line A B.

242
50
12100

65
32
130
195
2080

32
75
107
100
10700

75
106
181
100
18100

106
93
199
50
9950

93
50
143
75
715
1001
10725

59
50
2950

12100
2080
10700
18100
9950
10725
2950
Double areas collected.
66605 Sum.

Offsets taken on the line B C.

50
60
3000

60
85
145
50
7250

85
72
157
50
7850

72
32
104
150
5200
104
15600

78
32
156
234
2496

181
25
905
362
4525

3000
7250
7850
15600
2496
4525
Double areas collected.
40721 Sum.

Offsets taken on the line C D.

100
50
5000

50
44
94
100
9400

156
44
624
624
6864

148
52
296
740
7696

52
84
136
200
27200

84
75
159
200
31800

75
50
125
100
12500

75
50
3750

$$\left.\begin{array}{r}5000\\9400\\6864\\7696\\27200\\31800\\12500\\3750\end{array}\right\}\text{Double areas collected.}$$

104210 Sum.

Offsets taken on the line D A.

33
100
3300

33
65
98
100
9800

65
50
115
100
11500

50
28
78
100
7800

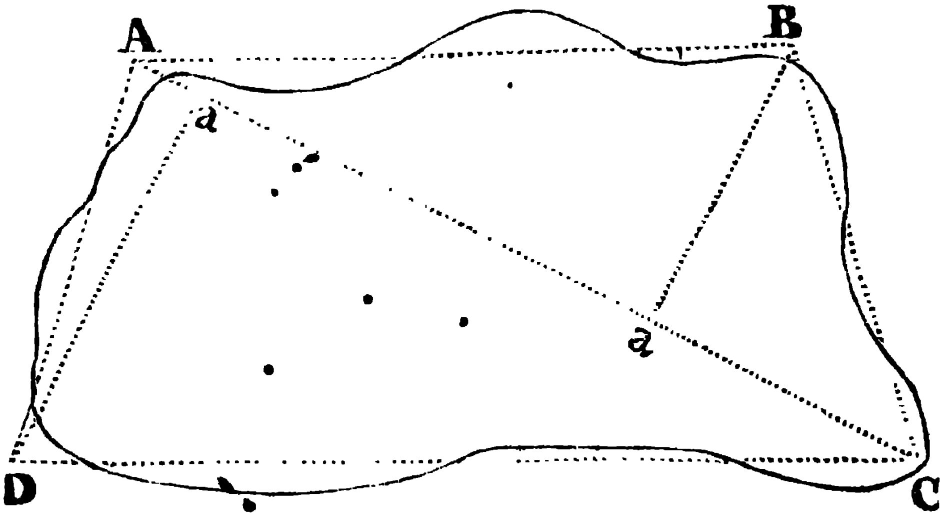
115
28
920
230
3220

$$\left.\begin{array}{r}3300\\9800\\11500\\7800\\3220\end{array}\right\}\text{Double areas collected.}$$

35620 Sum.

1270308
66605
40721 Whole double areas collected.
104210
35620
2)1517464
7.58732
4
2.34928
40
13.97120 Area 7A. 2R. 14P.

BY CASTING.



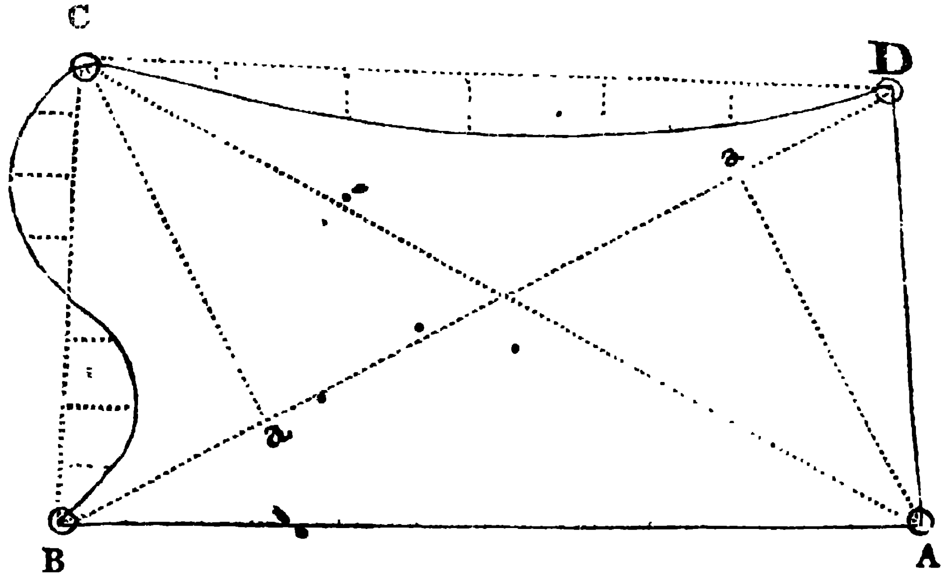
Having constructed the figure, draw the four dotted lines A B, B C, C D, and D A, in such a manner, that the parts included may be equal to those excluded; then the diagonal A C, will be found = 1364, and the perpendiculars D a = 636, and B a = 476 links.

```
    636 }
    476 } per.
   ----
   1112 sum.
   1364 diag.
   ----
   4448
  6672
 3336
1112
 -------
2)1516768
 -------
 7.58384
       4
 -------
 2.33536
      40
 --------
 13.41440   Area 7A. 2R. 13P.
 ========
```

4. It is required to find the area of a field, from the following notes.

B D	
1460	Diag.
1000	
Return to B.	
A C	
1480	Diag.
1000	
R. off A.	
D A	
672	
R. off D.	
C D	
1244	0
1000	47
800	70
600	85
400	68
200	30
000	0
R. off C.	

	B C	
0	720	
85	650	
112	550	
88	450	
	360	Cross the fence.
	300	83
	200	130
	100	100
	000	0
	R. off B.	
	A B	
	1350	
	1000	
Begin at	A. Range	W.



Having constructed the figure, you will find the perpendicular C a = 613, and the perpendicular A a = 618 links.

Trapezium A B C D.

613 } per.
618

1231 sum.
1460 diag.

73860
4924
1231

1797260

Insets taken on the line B C.

100
100
10000

100
130
230
100
23000

130
83
213
100
21300

83
60
4980

10000
23000
21300
4980
Double areas collected.

59280 Sum.

Offsets taken on the line B C.

88
90
7920

88
112
200
100
20000

112
85
197
100
19700

85
70
5950

7920
20000
19700
5950
Double areas collected.

53570 Sum.

Insets taken on the line C D.

200
30
6000

30
68
98
200
19600

68
85
153
200
30600

85
70
155
200
31000

70
47
117
200
23400

244
47
1708
976
11468

6000
19600
30600
31000
23400
11468
Double areas collected.

122068 Sum.

Double areas.

1797260 Trapezium A B C D.
53570 Offsets.
1850830 Sum.

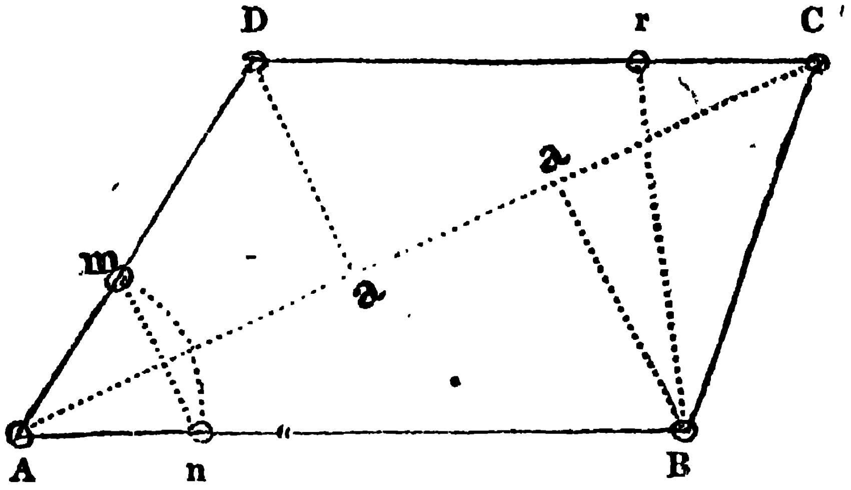
59280 } Insets.
122068 }

181348 Sum to be deducted from the above sum.

2)1669482 Whole field.
8.34741
4
1.38964
40
15.58560 Area 8A. 1R. 16P.

5. It is required to find the area of a field, from the following notes; neither of the diagonals having been measured, in consequence of obstructions.

	D A	
	476	
	L. off D.	
	C D	
	618	
	200	r, proof-line, 417 to B.
	L. off C.	
	B C	
	443	
	L. off B.	
	A B	
	723	
	192	from m to n.
	200	from A to m, on the line A D.
	200	from A to n, on the line A B.
Begin at	the angle	A range E.



Having constructed the figure, you will find the diagonal A C = 963, and the perpendiculars D a = 257, and B a = 316 links.

257 } per.
316 }

573 sum.
963 diag.

1719
3438
5157

2)551799

2.75899
4

3.03596
40

1.43840 Area 2A. 3R. 1P.

6. Required the plan and area of a field, from the following notes.

	B D	
	1437	Diag.
	1000	
	Return to B.	
	A C	Diag.
	939	
	L. off A.	
	D A	
	567	
	L. off D.	
	C D	
	712	
	L. off C.	
	B C	
	765	
	L. off B.	
	A B	
	1457	
	1000	
Begin at	A. Range	E.

Answer.

Having constructed the figure, you will find one of the perpendiculars = 560, and the other = 166 links; hence the area is = 5A. 0R. 34P.

7. It is required to lay down a field, and find its area, from the following notes.

	B D	
	662	Diag.
	Return to B.	
	A C	
	533	Diag.
	L. off A.	
	D A	
	168	
	L. off D.	
	C D	
	439	
	L. off C.	
	B C	
	356	
	L. off B.	
	A B	
	667	0
	400	62
	200	58
	000	0
Begin at	A. Range	E.

Answer.

Having constructed the figure, you find one of the perpendiculars = 168, and the other = 218 links; hence the area is = 1A. 2R. 6P.

8. It is required to lay down a field, and find its area, from the following notes; neither of the diagonals having been measured, in consequence of obstructions.

C E
1200
1000
L. off C.

	A C	
	1094	
	L. off A.	
	E A	
	1800	
	1000	
	L. off E.	
	D E	
	837	
	L. off D.	
	B D	
	1528	
	1000	
	860	C.
	L. off B.	
	A B	
	621	
Begin at	A. Range	N.

Answer.

Having constructed the figure, you will find the diagonal B E = 1927, and the perpendiculars = 580 and 637 links respectively; hence the area is = 11A. 2R. 36P.

9. The plan and area of a field are required from the following dimensions.

	D B	
	1730	Diag.
Return	to D.	
	A C	
	1660	Diag.
	R. off A.	

To	the	Fence.
99	1580	
110	1500	to A.
100	1450	
116	1400	
132	1300	
115	1200	
65	1100	
33	1000	
25	950	
40	900	
150	850	
210	800	
250	700	
255	630	
240	550	
218	500	
117	400	
41	300	
18	250	
15	200	
100	150	
140	100	
157	50	
165	000	
	R. off D.	

To	the	Fence.
60	1085	
82	920	to D.
80	850	
42	750	
40	700	
121	600	
140	550	
136	500	
70	400	
25	350	
17	300	
14	250	
30	200	
70	150	
92	100	
100	000	
	R. off C.	

To	the	Fenc
52	1440	
70	1340	to C.
60	1250	
37	1200	
33	1150	
45	1100	
83	1000	
70	900	
25	800	
12	750	
20	700	
40	650	
48	600	
54	500	
59	450	
60	400	
72	350	
84	300	
70	200	
86	150	
80	100	
75	000	
	R. off B.	
To	the	Fence
67	1005	
78	930	to B.
86	850	
90	750	
75	700	
40	650	
27	600	
36	550	
57	500	
85	450	
78	400	
58	300	
62	200	
79	100	
83	50	
80	000	
Begin	at A, and	go N.

Answer.

Having constructed the figure, you will find the perpendiculars A a = 810, and C a = 708 links.

Double areas.

2626140	Trapezium A B C D.
137945	Offsets taken on the line A B.
167800	Ditto on the line B C.
157520	Ditto on the line C D.
395420	Ditto on the line D A.
3484825	Sum.

Area 17A. 1R. 27$\frac{3}{4}$P.

PROBLEM III.

FIELDS OF MORE THAN FOUR SIDES.

When a field consists of more than four sides, you must divide it into triangles and trapeziums, agreeably to the directions given in Part III. Prob. 5. Then take the dimensions of each, as directed in the last two problems.

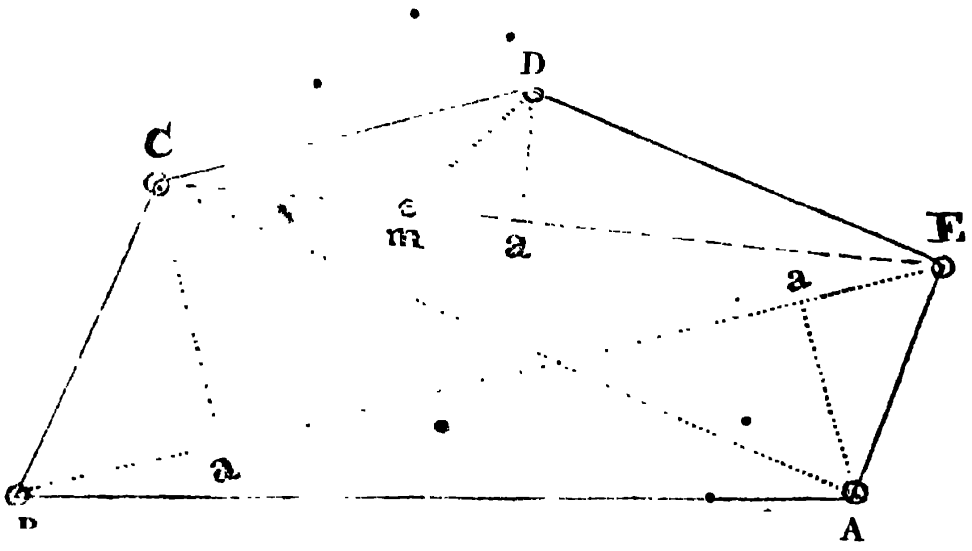
Note.—Notwithstanding what has already been advanced with regard to taking proof-lines, you are again requested never to omit measuring such distances as will enable you to confirm every part of your survey. Some may perhaps deem this tedious and superfluous ; but the satisfaction which a Surveyor finds, when his lines meet correctly, fully compensates him for his additional labour. Beside, he had certainly much better be at the pains of detecting his own errors, than expose himself to ridicule, by suffering them to be detected by some other Surveyor.

EXAMPLES.

1. It is required to find the area of a field, from the following notes.

E B	
1510	Diag.
1000	
R. off E.	
C E	
1238	Diag.
1000	
400	m, proof-line, goes to D, and measures 285.
R. off C.	

	A C	
	1200	Diag.
	1000	
	R. off A.	
	E A	
	393	
	R. off E.	
	D E	
	692	
	R. off D.	
	C D	
	620	
	R. off C.	
	B C	
	535	
	R. off B.	
	A B	
	1334	
	1000	
Begin at	A. Range	W.



Having constructed the figure, you will find the perpendiculars C a = 410, A a = 330, and D a = 215 links.

Trapezium A B C E.

410 } per.
336 }
740 sum.
1510 diag.
7400
370
74
1117400

Triangle C D E.

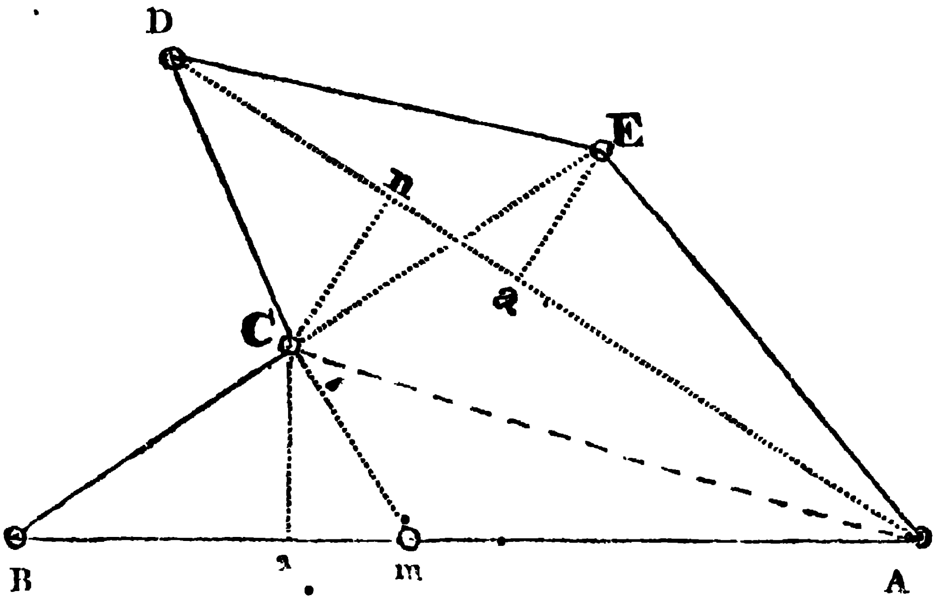
1238 base.
215 per.
6190
1238
2476
266170

1117400 } Double areas
266170 } collected.
2)1383570
6.91785
4
3.67140
40
26.85600 Area 6A. 3R. 27P.

2. It is required to find the area of a field, from the following notes.

D A 1042 Return to D.	Diag.
C E 420 R. off C.	Diag.
A C 768 R. off A.	Diag.
E A 585 R. off E.	
D E 518 R. off D.	
C D 365 L. off C.	

	B C 390 R. off B.	
Begin at	A B 1054 600 A. Range W.	m, proof-line, goes to C, and measures 260.



Having constructed the figure, you will find the perpendiculars C a = 223, C n = 200, and E a = 176 links.

Triangle A B C.

1054 base.
223 per.
3162
2108
2108
235042

Trapezium A C D E.

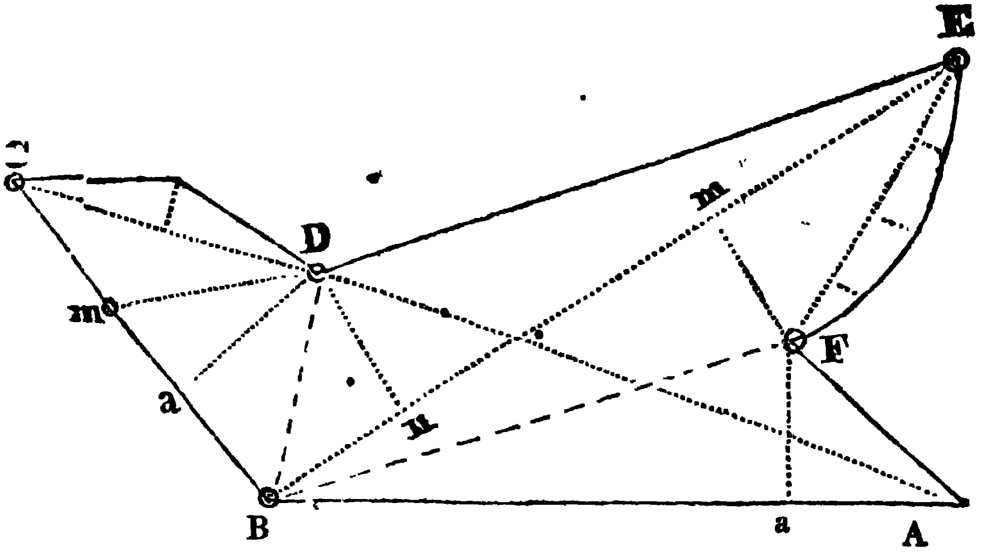
$\left.\begin{matrix}200\\176\end{matrix}\right\}$ per.
376 sum.
1042 diag.
752
1504
376
391792

```
  235042 } Double areas
  391792 }   collected.
2)626834
  3.13417
        4
  .53668
       40
 21.46720        Area 3A. 0R. 21P.
```

3. It is required to find the area of a field, from the following notes.

	F B	
	660	Diag.
	Return to F.	
	B E	
	970	Diag.
	L. off B.	
	D B	
	268	Diag.
	L. off D.	
	A D	
	832	Diag.
	R. off A.	
	F A	
	285	
	L. off F.	
	E F	
0	384	
40	300	
53	200	
32	100	
0	000	
	R. off E.	
	D E	
	804	
	L. off D.	

	C D	
0	383	
52	200	
0	000	
	R. off C.	
	B C	
	475	
	300	m, proof-line, goes to D, and measures 255.
	R. off B.	
	A B	
	850	
Begin at	A. Range	W.



Having constructed the figure, you will find the perpendiculars F a = 185, F m = 185, D n = 190, and D a = 216 links.

Triangle A B F.
850 base.
185 per.
4250
6800.
850
157250

Trapezium B D E F.
185 } per.
190 }
375 sum.
970 diag.
26250
3375
363750

Triangle B C D.	Offset taken on the line C D.
475 base.	383
216 per.	52
2850	766
475	1915
950	19916
102600	

Offsets taken on the line E F.

32	53	3200
100	40	8500
3200	93	9300
32	100	3360
53	9300	24360 sum.
85	84	
100	40	
8500	3360	

$$\left.\begin{array}{r}3200\\8500\\9300\\3360\end{array}\right\}\text{Double areas collected}$$

$$\left.\begin{array}{r}157250\\363750\\102600\\19916\\24360\end{array}\right\}\text{Whole double areas collected.}$$

2)667876

3.33938

4

1.35752

40

14.30080 Area 3A. 1R. 14P.

4. It is required to lay down a field, and find its area, from the following notes.

	D B 1440 1000 Return to D.	Diag.
	A C 1078 L. off A.	Diag.
	E A 1324 1000 Return to E.	Diag.
	D F 712 L. off D.	Diag.
	A D 818 L. off A.	Diag.
	F A 755 L. off F.	
	E F 692 L. off E.	
	D E 754 R. off D.	
	C D 540 L. off C.	
	B C 1048 L. off B.	
Begin at	A B 1360 1000 A. Range	E.

Answer.

Having constructed the figure, and divided it into two trapeziums, A B C D, and A D E F; you will find the perpendicular which falls from the angle C upon the diagonal D B = 315 links; and that which falls from the angle A upon the same diagonal = 758 links.

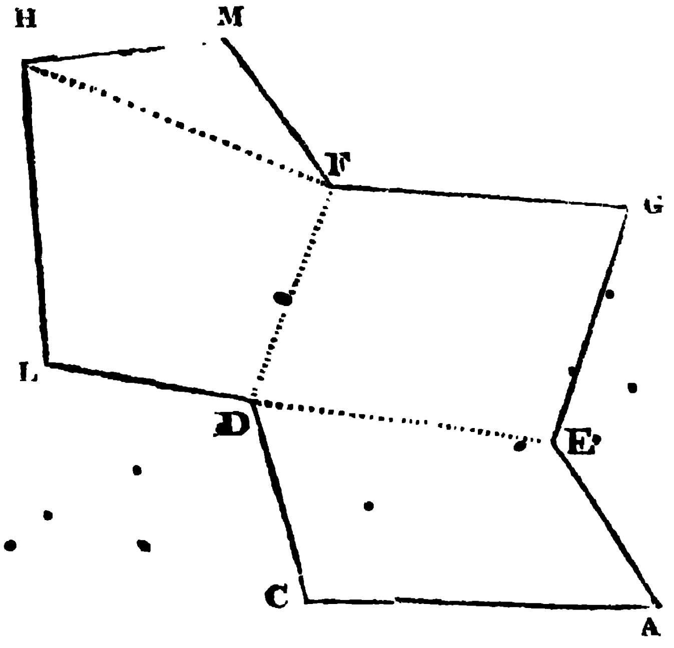
The perpendicular which falls from the angle D upon the diagonal E A, you will find = 425 links; and that which falls from the angle F upon the same diagonal = 287 links.

Hence the area is = 12A. 1R. 80P.

5. Required the plan and area of a field, from the following notes.

E B 424 R. off E.	Proof-line.
F E 750 L. off F.	Diag.
M F 400 R. off M.	
H M 460 R. off H.	227 to K, proof-line.
L H 700 R. off L.	
D L 430 Return to D.	
F L 740 R. off F.	Diag.
H F 730 400 R. off H.	Diag. K.
D H 920 R. off D.	Diag.
G D 950 Return to G.	Diag.

	G E 580 R. off G.	
	F G 680 R. off F.	
	D F 540 R. off D.	Diag.
	A D 1050 R. off A.	Diag.
	E A 450 R. off E.	
	D E 670 R. off D.	Diag.
	C D 500 R. off C.	
Begin at	A C 780 500 A. Range	B. W



Answer.

Having constructed the figure, you will find the perpendiculars of the trapezium A C D E = 354 and 195; of D F G E = 404 and 340; of D L H F = 426 and 316; and the perpendicular of the triangle F H M = 227 links.

Hence the area of the field is = 10A. 2R. 25P.

6. Required the plan and area of a field, from the following dimensions.

	B D	
	1480	Diag.
Return	to B,	Line 14.
	G E	
	1725	Diag.
L. off	G,	Line 13.
	C G	
	1295	Diag.
L. off	C,	Line 12.
	F C	
	935	Diag.
L. off	F,	Line 11.
	D F	
	793	Diag.
R. off	D,	Line 10.

	G D	
0	358	
37	300	
49	250	
60	200	
66	150	
62	100	
30	50	
0	000	
R. off	G,	Line 9.
	F G	
0	783	
78	700	
134	650	
154	600	
170	550	
172	500	
150	450	
185	400	
208	350	
205	300	
180	250	
149	200	
107	150	
62	100	
24	50	
0	000	
R. off	F,	Line 8.
	E F	
0	1043	
36	1000	
67	900	
85	800	
100	700	
140	600	
152	550	
143	500	
135	450	
110	400	
65	350	
50	300	
40	200	
25	100	
0	000	
R. off.	E,	Line 7.

	C E	
0	743	
70	600	
135	500	
160	450	
185	400	
190	350	
170	300	
150	250	
95	200	
60	100	
0	000	
R. off	C,	Line 6.
	D C	Diag.
	1000	
L. off	D,	Line 5.
	A D	
	700	0
	600	50
	500	130
	450	160
	400	173
	350	184
	300	190
	250	150
	200	107
	100	60
	000	0
L. off	A,	Line 4.
	C A	
	1578	Diag.
R. off	C,	Line 3.
	B C	
0	865	
60	750	
104	650	
72	600	
88	500	
100	400	
86	350	
75	300	
95	200	
80	100	
70	600	
R. off	B,	Line 2.

To	the	Fence.
80	1820	
73	1750	to B.
60	1600	
56	1500	
70	1400	
95	1300	
120	1200	
105	1100	
110	1000	
140	900	
186	800	
184	700	
125	600	
114	500	
93	400	
86	300	
75	200	
70	100	
0	000	
Begin at	A,	Range W. Line 1.

Answer.

Having constructed the figure, you will find the perpendiculars of the trapezium A B C D, falling upon the diagonal C A, to measure 862 and 314 links; the perpendicular of the triangle D G C, falling upon the diagonal C G, to measure 184 links; and the perpendiculars of the trapezium C E F G, falling upon the diagonal G E, to measure 513 and 300 links.

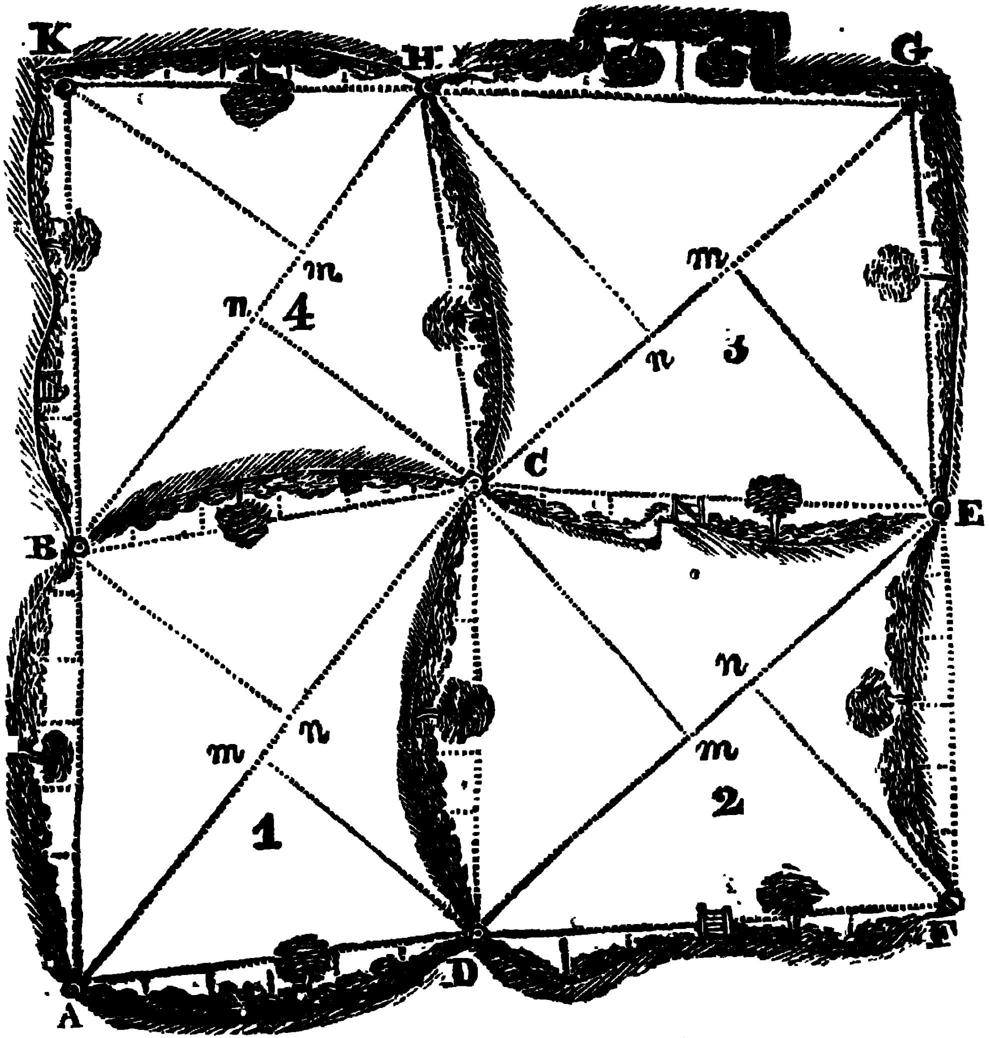
Double areas.

1855728	Trapezium A B C D.
238280	Triangle D G C.
1402425	Trapezium C E F G.
362460	Offsets taken on the line A B.
133750	Ditto on the line B C.
143250	Ditto on the line A D.
149010	Ditto on the line C E.
157548	Ditto on the line E F.
200374	Di[illegible] on the line F G.
30696	Ditto on the line G D.
4673521	Sum.

Area 23A. 1R. 18$\frac{3}{4}$P.

7. Draw a plan of a small estate, consisting of four fields, and find the respective areas of the different inclosures, and the content of the whole, from the following dimensions.

Note.—The field-notes in this example are entered from the left towards the right; but in all the foregoing examples, they are entered from the right towards the left. Both methods are consequently exhibited; and, of course, the learner is at liberty, when he commences field-practice, to follow that of which he most approves.



Scale 4 Chains to an Inch.

	To C	
0	685	
54	600	
92	500	
105	400	
100	300	
78	200	
44	100	
0	000	
Go from	D,	Line 5.
	To D	
	632	0
	600	24
	500	55
	400	78
	300	82
	250	Gate.
	200	76
	100	52
	000	0
Go from	A,	Line 4.
	To A	
	995	Diag.
Go from	C,	Line 3.
	To C	
0	615	
46	500	
53	400	
62	300	
60	200	
50	100	
0	000	
Go from	B,	Line 2.
	To B	
0	662	
53	600	
88	500	
96	400	
92	300	
70	200	
35	100	
0	000	
Begin	at A,	and go N. Line 1.

To	the	Fence.
	668	22
To G	638	24
	600	26
	500	42
	400	48
	300	45
	200	30
	100	18
	000	0
Go from	E,	Line 10.
	To E	
	965	Diag.
Go from	D,	Line 9.
	To D	
0	735	
32	700	
75	600	
55	500	
20	430	
Gate	380	
28	300	
42	200	
40	100	
0	000	
Go from	F,	Line 8.
	To F	
	593	0
	500	30
	400	52
	300	57
	200	48
	100	32
	000	0
Go from	E,	Line 7.
	To E	
	712	0
	600	43
	500	52
	400	45
	340	Gate.
	274	28 + 52.
	200	76
	100	42
	000	0
Go from	C,	Line 6.

	Finis.	
	To H.	
	895	Diag,
Go from	B,	Line 16.
	To B	
	720	0
	600	40
	500	48
	460	Gate,
	400	32,
	350	18
	300	28
	200	68
	100	55
	000	34
Go from	K,	Line 15.
To	the	Fence,
	580	28
To K	546	30
	500	32
	400	46
	300	45
	200	40
	100	34
	000	0
Go from	H,	Line 14.
	To G	
	908	Diag.
Go from	C,	Line 13.
	To C	
0	624	
54	500	
65	400	
63	300	
52	200	
30	100	
0	000	
Go from	H,	Line 12.
	To H	
	750	0
	700	18
	600	38
	490	60 + 35
	350	104
	220	15 + 80
	100	25
	000	30
Go from	G,	Line 11.

Answer.

Having drawn the plan, you will find the perpendiculars of the different trapeziums to measure as follow: viz.

D m = 426, and B n = 400, in No. 1;
C m = 503, and F n = 448, in No. 2;
H n = 515, and E m = 498, in No. 3; and
C n = 428, and K m = 439, in No. 4.

AREA OF NO. 1.

Double areas.

821870 Trapezium A B C D.
84786 Offsets on A B.
54890 Ditto on B C.
72968 Ditto on A D.
1034514 Sum.
93790 Insets on C D.
2)940724 Difference.
4.70362 Area in square links.
4
2.81448
40
32.57920 Area 4A. 2R. 32½P.

AREA OF NO 2.

Double areas.

917715 Trapezium D C E F.
93790 Offsets on C D.
55510 Ditto on D F.
1067015 Sum.
60758 Insets on C E.
43590 Ditto on E F.
104348 Sum.
962667 Difference.

Area 4A. 3R. 10P.

AREA OF NO. 3.

Double areas.

919804	Trapezium C E G H.
60758	Offsets on C E.
42480	Ditto on E G.
81310	Ditto on G H.
1104352	Sum.
54096	Insets on C H.
1050256	Difference.

Area 5A. 1R. 0P.

AREA OF NO. 4.

Double areas.

775965	Trapezium B C H K.
54096	Offsets on C H.
41024	Ditto on H K.
57200	Ditto on K B.
928285	Sum.
54890	Insets on B C.
873395	Difference.

Area 4A. 1R. 18½P.

CONTENT.

No.	A.	R.	P.
1.	4	2	32½
2.	4	3	10
3.	5	1	0
4.	4	1	18½
Sum	19	0	21

Note 1.—In the last example, every field is measured separately; but they are so connected by the chain-lines, that no difficulty can arise to the learner, in planning them. It may also be observed that no proof-lines were measured; but they should never be omitted in practice. If they be, the Surveyor cannot depend upon the accuracy of his work.

2.—If the foregoing Estate be laid down upon a sheet of drawing paper, by a scale of one chain, or of two chains to an inch, a finished Plan may then be made, and ornamented with Indian ink, in a similar manner to Plates IX. and XI. Or the quick-wood hedges may be made by a pen and Indian ink; or they may be represented by running narrow shades of colouring along the lines which form the boundaries of the fields; and each field may then be washed over with a different colour, mixed up thinly with water, and laid on with a small brush, or camel's hair pencil. (See Part V. for the method of transferring a rough Plan to a clean sheet of paper, in order to make a finished Plan, with proper embellishments.)

3.—In drawing the finished Plan, all the out-boundaries may be considered as belonging to the fields which they respectively adjoin; that fence from B to C, may be made as belonging to No. 1; that from C to D, as belonging to No. 2; that from C to E, as belonging to No. 3; and that from C to H, as belonging to No. 4. (See a remark on the 39th page, relating to fences.)

4.—The title of the finished Plan of the foregoing Estate, may run thus: Plan of an Estate lying in the Parish of Bradford, in the West-Riding of the County of York.

PROBLEM IV.

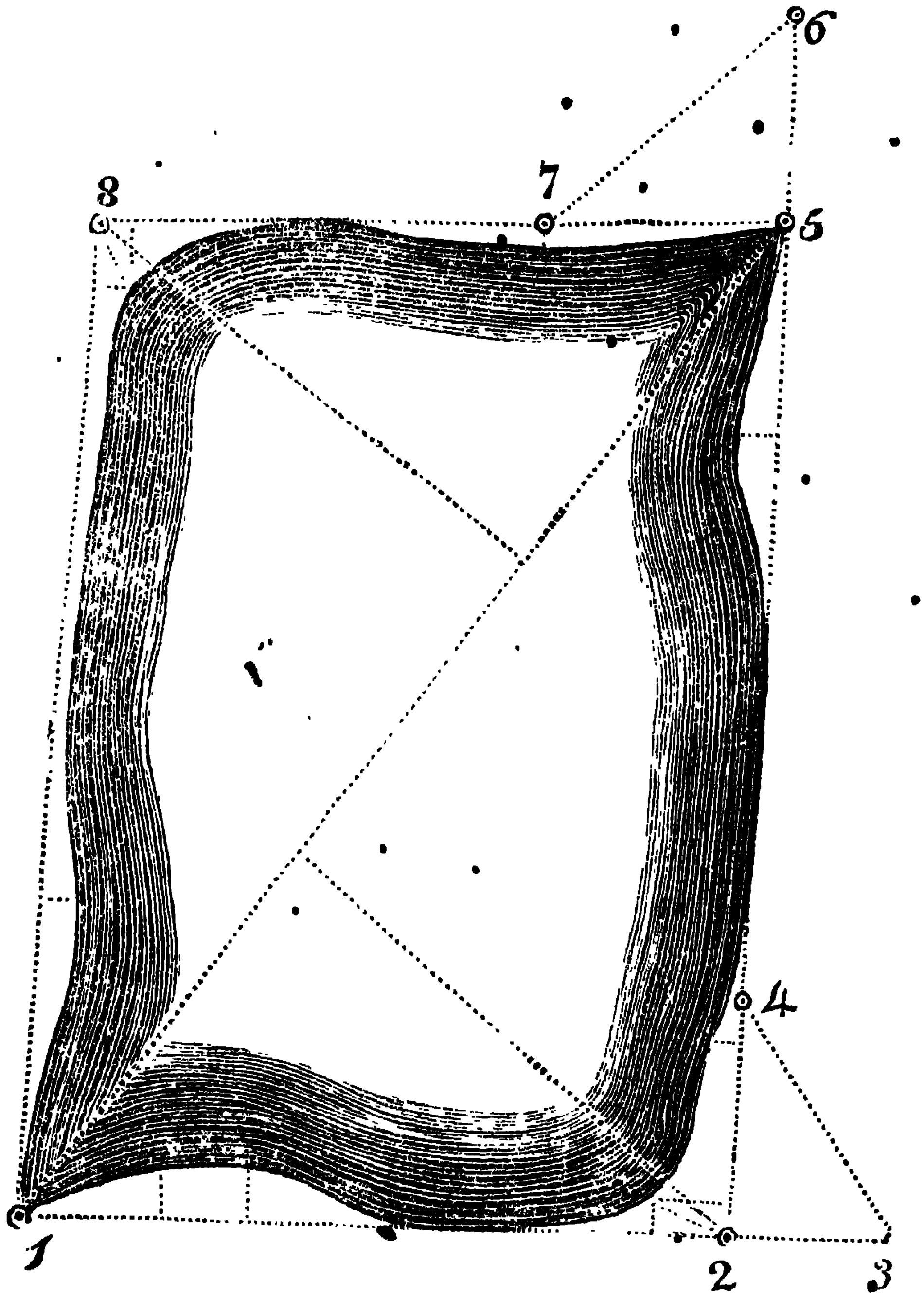
MERES AND WOODS.

The method of measuring Meres and Woods by the Chain and Cross, has already been shewn in Part III. It is here proposed to survey them by the Chain only.

In this case, you must not only measure on the outside of the mere, or wood, and take insets as before directed; but also take such external angles, or tie-lines, as will enable you to lay down the figure.

EXAMPLE.

Let the following figure represent a mere, the area of which is required.



Begin at + 1, and measure eastward as far as + 2, taking insets as you proceed; then produce the line to + 3. Return to + 2, and measure northward as far as + 4; thence run a line backward to + 3, which will tie the first and second lines. Return to + 4, continue the line to + 5, and produce it to + 6.—Return to + 5, and proceed westward to + 7, the distance between which and + 6, being measured, will tie the second and third lines. Return to + 7, and continue the line to + 8. From + 8 proceed to + 1, and you will have obtained the following dimensions.

Note.—Here it may be observed, that after the first three lines are laid down, the fourth line will exactly reach from + 8 to + 1; if the operations have been performed with correctness.

0	1625	to + 1.
60	1100	
	1000	
23	800	
30	600	
60	96	
0	000	
From	+ 8,	go S.
0	1150	to + 8.
100	1100	
	1000	
0	900	
0	700	
40	400	+ 7, which is 550
0	000	from + 6.
Return to	+ 5, and	go W.
	2000	to + 6.
0	1650	+ 5.
56	1300	
0	1000	
0	550	
	400	+ 4, which is 490
40	300	from + 3.
103	48	
0	000	
Return to	+ 2, and	go N.
	1500	to + 3.
0	1200	+ 2.
50	1100	
	1000	
0	850	
0	600	
100	400	
80	250	
0	000	
Begin at	+ 1,	Range E.

Answer.

Having constructed the figure, you will find the diagonal, drawn from + 1 to + 5 = 2085, the perpendicular from + 2 upon the diagonal = 950, and that from + 8 = 890 links.

Double areas.

3836400 Trapezium made by stations 1, 2, 5, and 8.

84500 1 line
87380 2 —
53000 3 —
118120 4 —
Insets taken on the different lines.

343000 Whole Insets.

3493400 Mere. Area 17A. 1R. 35P.

PROBLEM V.

TO MEASURE AND PLAN ROADS, RIVERS, CANALS, &c.

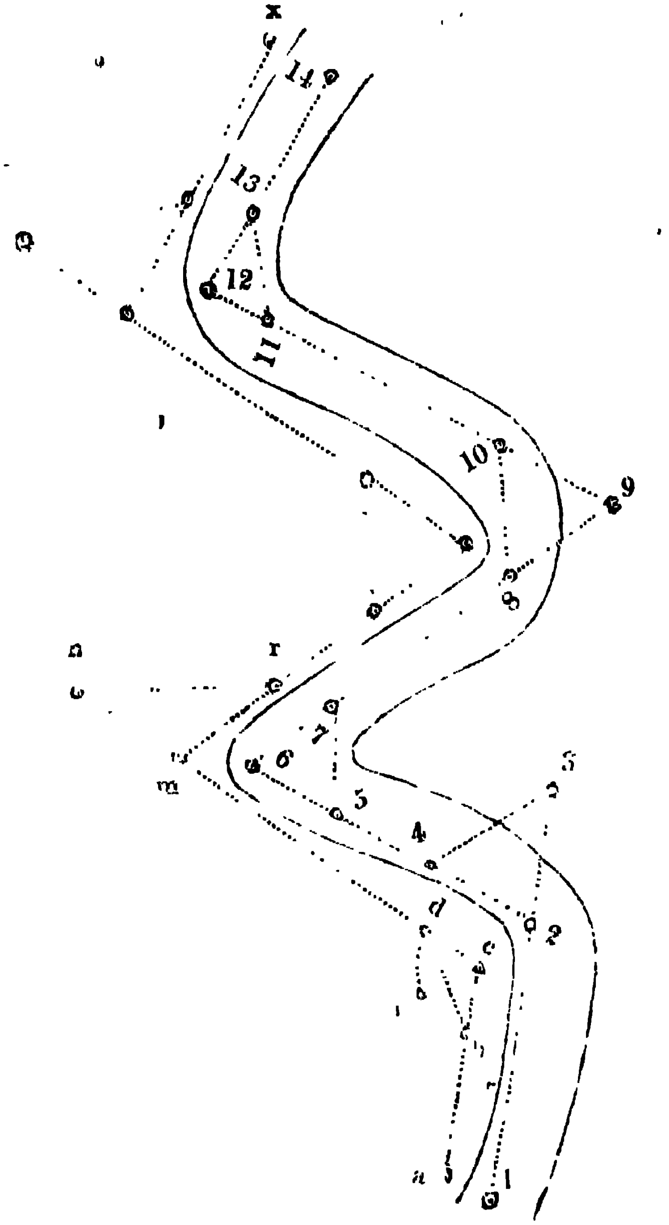
In measuring Roads, Rivers, or Canals, angles or tie-lines must be taken at the different turns, in order to lay down the chain-lines; and offsets must be taken to the boundaries, as you proceed, to enable you to draw the plan.

Note 1.—The length of a road is generally returned either in miles, furlongs, and poles, or else in miles and yards. (See the Table, page 43.)

2.—A machine called a "Perambulator" is sometimes used to ascertain the lengths of roads. It has a wheel of 8 feet 3 inches, or half a pole, in circumference, which being made to pass over the ground, puts in motion the clock-work within, and the distance measured is pointed out by an index on the outside. This instrument is much more expeditious for measuring the length of a road, than the chain; but it is certainly less correct; for by the wheel passing over stones, sinking into holes, &c. the distance is made to appear more than it is in reality.

EXAMPLES.

1. Let the following figure represent a serpentine road, a plan of which is required.



Begin at + 1, and measure to + 3, taking offsets on both sides, as you proceed. Return to + 2, and measure to + 4, from which run a line to + 3, which will tie the first and second lines. Return to + 4, and continue the line to + 6. From + 6, proceed as before, until you arrive at + 14; and you will have obtained the following dimensions, from which a plan may be drawn.

	To + 14.	
58	350	60
68	200	44
	150	+ 13 is 184 from + 11
50	100	80
Go from	+ 12,	Line 5.
	To + 12.	
30	720	
70	650	
	600	+ 11.
86	550	36
70	300	50
+ 8 is 200 from + 10	200	
120	135	Cross-fence.
Go from	+ 9,	Line 4.
	To + 9.	
	700	
	600	Cross-fence.
	500	+ 8.
38	480	84
40	300	60
52	180	65
	150	+ 7 is 160 from + 5.
50	100	
Go from	+ 6,	Line 3.
	To + 6.	
20	512	
50	450	
52	380	70
	350	+ 5.
20	300	80
	200	+ 4 is 232 from + 3.
18	100	93
Go from	+ 2,	Line 2.
	To + 3.	
	600	
	480	Cross-fence.
	400	+ 2
38	350	95
15	300	
28	200	80
55	000	70
Begin	at + 1,	Line 1.

2. Let the foregoing figure represent a river, a plan of which is required.

Begin at a, and measure to c; taking offsets to the river's edge, as you proceed. From c measure to d; and there take the tie or chord-line d b, which will enable you to lay down the first and second lines. Continue the second line to n; and from m, measure to r, at which place take the tie-line r n; and thus proceed until you come to the end of your survey at x.

If the breadth of the river be every where nearly the same, its breadth taken in different places, by the next Problem, or by Problem 10, Part III. will suffice; but if it be very irregular, dimensions must be taken on both sides, as above.

When the area is required, it must be found from the plan, by dividing the river into several parts; and taking the necessary dimensions by the scale.

Note.—Any Bog, Marsh, Mere, or Wood, whatever may be its number of sides, may be measured by this Problem.

PROBLEM VI.

TAKING DISTANCES BY THE CHAIN AND SCALE.

EXAMPLE.

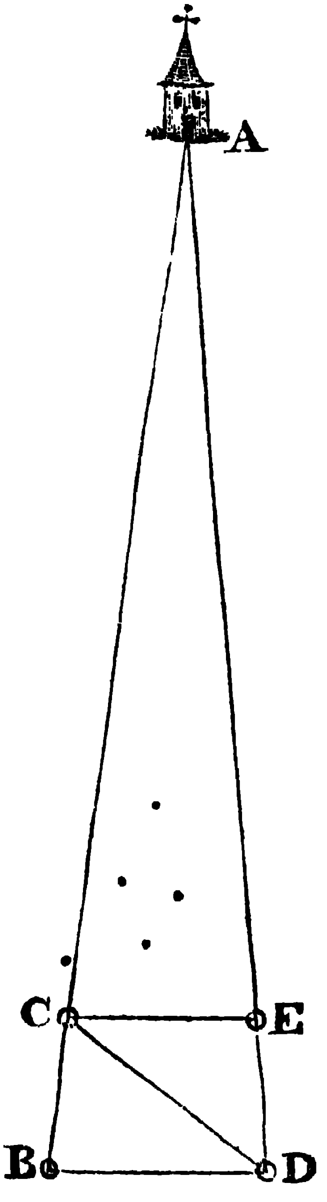
Required the distance of an object at A, from B.

First, make a station at B; then, in a direct line with B A, set up a pole, suppose at C; measure the distance B C. Return to B, and measure in any direction, making an angle with B C, suppose to D; then set up a pole in a direct line with D A, as at E. Measure the lines D E and E C, and also the diagonal C D; these will enable you to construct the trapezium B C E D.

The lines B C and D E, produced, will evidently meet at A.

Measure the line B A with the same scale, by which you have constructed the trapezium, and it will be the distance required.

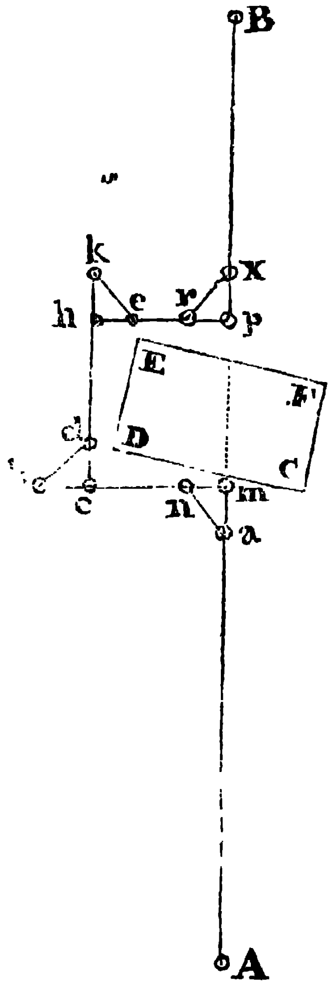
Note.—This method may be well applied to measuring the breadth of a river, or the distance of any inaccessible object; and any person, acquainted with trigonometry, may easily find the correct distance, after measuring the lines before mentioned.



PROBLEM VII.

TO ERECT A PERPENDICULAR BY THE CHAIN, OR TO MEASURE LINES UPON WHICH THERE ARE IMPEDIMENTS.

EXAMPLE.



Suppose C D E F to represent the base of a building, through which it is necessary a line should pass to an object at B, seen from A.

Measure from A to m; and from m, measure back to a, 40 links. Let one end of the chain be kept fast at a, and the eightieth link at m; take hold of the fiftieth link, and stretch the chain so that the two parts a n, and m n, may be equally tight; then will m n be perpendicular to a m.

For m n will be 30, a m 40, and a n 50 links; or the sides of the right-angled triangle a m n will be in proportion to each other as 3, 4, and 5. (See Prob. 18. Part I.)

Measure from m, upon the line m n continued, until you are clear of the impediment, as at c; then continue the line 40 links farther, to b. Find by the above process the perpendicular c d; and proceed in that direction till you are beyond the building, as at h. Again erect the perpendicular h e, upon which measure till you have made h p, equal to m c;

and you will then be in a direct line with m A. Erect the perpendicular p x, which (if you have conducted the work with correctness,) will be in a right line with B. Measure the distance p B; then A m, added to c h (= m p), and p B, will give the whole length of the line A B.

PROBLEM VIII.

HAVING THE PLAN OF A FIELD, AND ITS TRUE AREA, TO FIND THE SCALE BY WHICH IT HAS BEEN CONSTRUCTED.

RULE.—By any scale whatever, measure such lines as will give you the area of the figure; then say, as this area is to the square of the scale by which it was found, so is the true area, to the square of the scale required.

EXAMPLE.

Suppose the true area of a field, the plan of which is given, to be 9A. 1R. 32P.; and that by a scale of 2 chains to an inch, I find the area to be 4A. 0R. 32P.; required the scale by which the plan was constructed.

First, 9A. 1R. 32P. = 945000 square links; and 4A. 0R. 32P. = 420000 square links; then, as 420000 : 4 :: 945000 : 9. Hence, it appears, the plan was constructed by a scale of 3 chains to an inch.

Note.—The principle of this process is, that the areas of similar figures are to each other as the square of their homologous sides. (Theo. 16, Part I.)

THE METHOD

OF

MEASURING HILLY GROUND.

A LINE measured upon the acclivity or declivity of a hill, will evidently exceed one measured upon the horizontal base; consequently, if a plan be laid down by the hypothenusal lines, every part will be thrown out of its true situation; so that the boundaries of a mountainous lordship would appear distorted and unnatural; and the estate would scarcely be recognised by its own inhabitants.

Surveyors, therefore, agree in their opinions concerning the necessity of reducing hypothenusal to horizontal lines, for the purpose of planning; but they differ with regard to the modes of finding the area; some contending that it should be computed according to the hypothenusal, and others according to the horizontal lines.

The advocates for the horizontal measure assert, that no more corn, trees, &c. can grow upon the surface of a hill, than upon a space equal in area to its base, admitting both to be of the same quality; and that hilly ground, in general, is less productive than plains; and its cultivation attended with more expense. The advocates on the other hand state, that the surveyor has nothing to do with the quality of the land; and that it is his duty to return the measurement of the surface, and leave the value to those whom it more nearly concerns.

The horizontal measure, however, is now generally adopted, except for paring, reaping, &c. in which cases the hypothenusal measure is very justly preferred. (See Deut. xxiv. 14, 15; and Prov. xxii. 16.)

Methods used by Practical Surveyors to reduce hypothenusal to horizontal Lines.

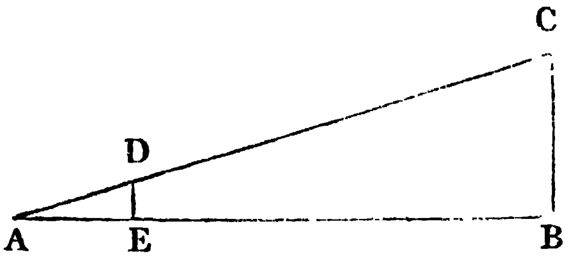
METHOD I.

When the hill is of a regular slope, take its altitude with a Theodolite, or with a Quadrant; then, by a trigonometrical canon, in which the hypothenuse may be counted 100 links, determine the number of links in the base. These deducted from 100, will shew the number of links by which each chain must be shortened, for the purpose of planning.

Note.—For the principles of Trigonometry, the reader is referred to the works of Simpson, Emerson, Vince, Horsley, Keith, Bonnycastle, and the Rev. W. Wright, on that subject; and for the history, construction, and use of Logarithms, to Dr. Hutton's Mathematical Tables.

EXAMPLE.

Suppose the altitude of a hill to be 16° 15′, and the length of a line measured upon its surface, to be 2550 links; required the length of the line, that must be used in planning.



In the right-angled triangle A B C, are given the hypothenuse A C = 2550, and the angle B A C = 16° 15′, to determine the base A B. Or A D = 100, and the angle E A D = 16° 15′ to find A E.

As Radius	10.00000
Is to the hypoth. A D = 100 links	2.00000
So is the co-sine of the angle E A D = 16° 15′ ...	9.98229
To A E = 96 links	1.98229

Hence it appears, that 4 links must be subtracted from each chain ; consequently, (25 × 4 + 2 =) 102 links must be taken from A C ; hence, A B = 2448 links, the line required.

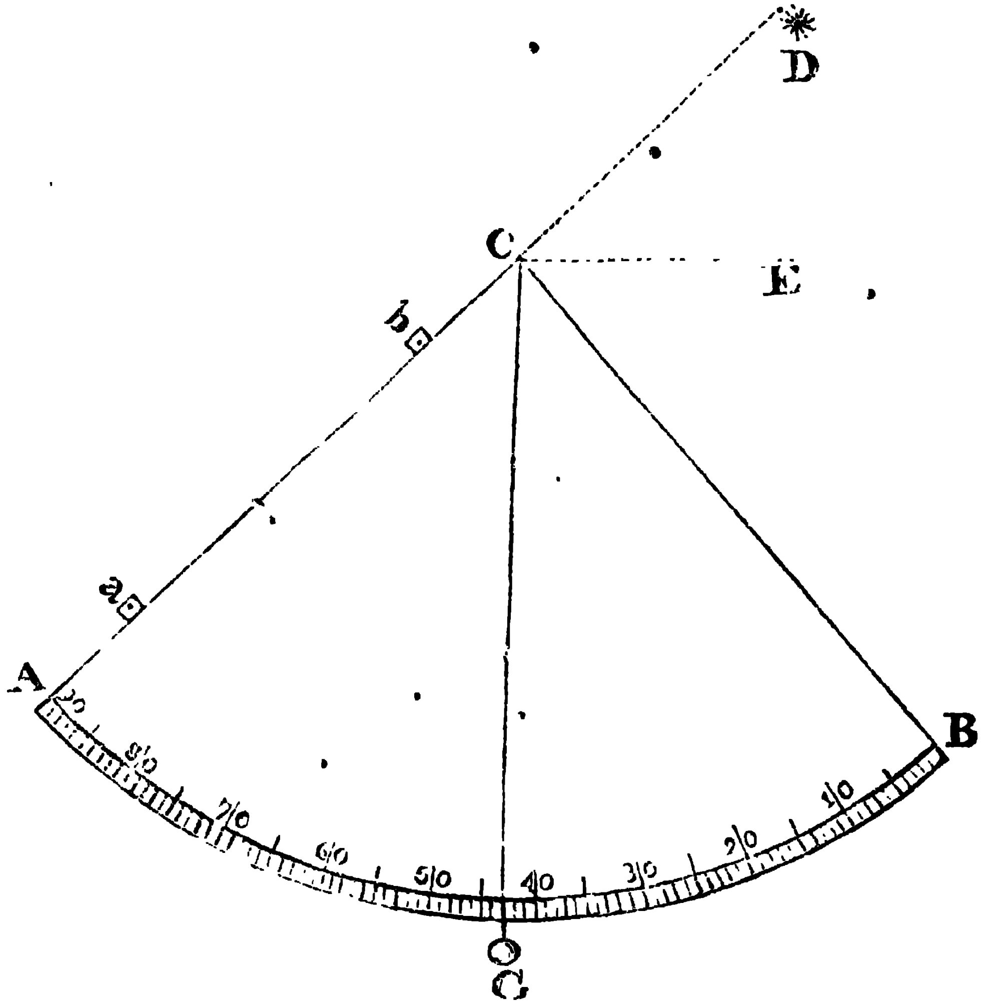
Proof.—As 1 : 2550 :: .96005 (the nat. co-sine of 16° 15′) : 2448.1275 links = A B.

A Table for reducing hypothenusal to horizontal Lines.

Different Altitudes of Hills.		Links to be subtracted from each Chain measured upon the Surface.	Deg.	Min.	Links.
Deg.	Min.	Links.			
			25	51	10
			27	8	11
			28	21	12
			29	32	13
			30	42	14
5	44	½	31	47	15
8	6	1	32	52	16
11	28	2	33	54	17
14	4	3	34	55	18
16	16	4	35	54	19
18	12	5	36	52	20
19	57	6	37	49	21
21	34	7	38	41	22
23	4	8	39	39	23
24	30	9	40	32	24

Note.—To construct the above Table, suppose the base A B, in the preceding triangle, to be = 99.5, and the hypothenuse A C = 100 ; then, by Trig. as 100 : 1 :: 99.5 : .995, the nat. co-sine of the angle B A C = 5° 44′ —In the same manner, the rest of the angles are obtained, by different operations, accounting the base 99 in finding the second angle, 98 in finding the third, &c.

A Quadrant for taking the Altitude of Hills, Steeples, &c.



By those who do not wish to incur the expense of a Theodolite, a Quadrant may be made of about twelve inches radius, by which the altitude of a hill, steeple, &c. may be taken to a tolerable degree of accuracy.

The arc A B must be correctly divided into 90 equal parts or degrees; and numbered from right to left. Upon the radius A C, must be fixed two brass sights, a and b, through each of which must be made a very fine hole; and from the centre C must be suspended a plummet, by a thread of fine silk.

Note.—In taking the altitude of an object, the quadrant is commonly held in the hand; but it is much better to fix it to a staff, which may be done by means of a nail, passing through the quadrant and staff, upon the end of which must be screwed a small nut.

To take the Altitude of a Hill with the Quadrant.

Upon the top of the hill fix an object, exactly as high as your eye will be from the ground, in taking the observation. At the bottom of the hill, fix the quadrant-staff perpendicularly to the horizon; which may be easily done by means of the plummet. Then with one eye at A, the other being closed, look through the sights, turning the quadrant until you perceive the object at D; so will the arc B G, cut off by the plumb-line C G, be the measure of the angle D C E, or the ltitude of the hill, in degrees, &c.

Note.—When you take the altitude of a hill by a Theodolite, the observation must be referred to an object fixed upon the top of the hill, exactly as high as the telescope.

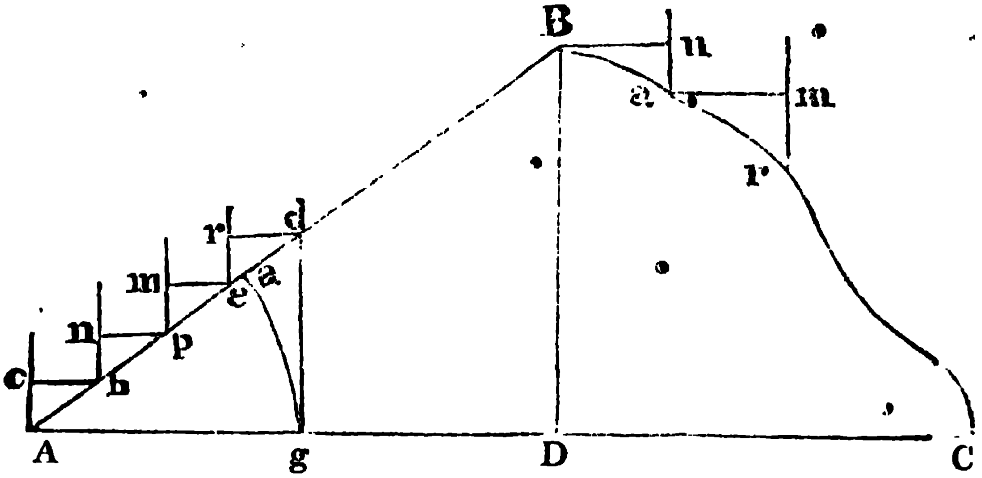
To take the Altitude of a Steeple, &c. with the Quadrant.

Screw the quadrant fast to its staff, so that the plummet may hang exactly at 45°, when the staff is perpendicular to the horizon. Then, move the staff backward or forward (always keeping it perpendicular) until you can see the top of the object through both the sights. Measure the distance between the bottom of the staff and that of the object, which being added to the height of your eye, will give the altitude required.

METHOD II.

As the foregoing method of reducing hypothenusal to horizontal lines, can only be applied, with accuracy, when hills are of a regular slope; surveyors, in general, elevate the chain, as they ascend or descend a hill, in order to preserve the horizontal line.

EXAMPLE.



Suppose the lines A B and B C, to represent the acclivity and declivity of an irregular hill; it is required to measure them, and to preserve the horizontal lines A C.

From A, stretch the chain toward B, and suppose it to reach to a; the same extent, upon the base, will evidently reach from A to g; and a perpendicular erected from g will intersect the line A B in d; hence the distance A d, upon the hypothenuse, will make one chain upon the base......At A, stick your offset-staff into the ground, perpendicularly to the horizon, and let your assistant hold the chain, suppose at the twenty-fifth link, close to the surface of the hill, as at b; at the same time you must elevate the end of the chain to c, forming the horizontal line c b; then move forward to b, at which place fix your staff again, as before. Let your assistant hold the fiftieth link at p, while you elevate the twenty-fifth to n, forming the horizontal line n p. Again, fixing your staff at p, elevate the fiftieth link to m, while your assistant holds the seventy-fifth at e. Lastly, put down the staff at e, and elevate the seventy-fifth link to r, while the hundredth is held by your assistant at d. There he must put down an arrow; and thus you must proceed until you arrive at B, where you will have obtained the horizontal line A D.

In descending from B to C, let your assistant hold one end of the chain at B, while you elevate, suppose, the fiftieth link to n, forming the horizontal line B n; then fix the staff at a, perpendicularly to the horizon, and touching the chain at n. Next, let your assistant hold the fiftieth link at a, while you elevate the hundredth to m, and put down the staff at r, as before. In this manner, having arrived at C, you will have obtained the horizontal line D C, which being added to A D, will give the base or horizontal line A C, as required.

Note 1.—If you wish to obtain the hypothenusal, as well as the horizontal line, divide your field-book into four columns, in one of which you must enter the number of links between a and d, &c. which being added to the horizontal, will give the hypothenusal line.

2.—When the ascent or descent of a hill is great, you will not be able to elevate more than 10 or 15 links of the chain at one time; for, in such cases, if you attempt to elevate 20 or 30 links, you will find that the perpendiculars A c, b n, &c. will exceed your own height, before you can form the horizontal lines c b, n p, &c. (See the last Figure.)

METHOD III.

Hypothenusal lines may likewise be expeditiously and correctly reduced to horizontal ones, during the survey, by an instrument invented by Mr. ROBERT KING, of Scarborough, Land-Surveyor, and called " King's Quadrant."

THE DESCRIPTION AND USE OF KING'S SURVEYING QUADRANT.

(See Adam's Treatise on Mathematical Instruments, corrected by W. Jones, Mathematical Instrument-Maker, Holborn, London.)

DESCRIPTION.

" THE quadrant is fitted to a wooden square, which slides upon an offset-staff, and may be fixed at any height by means of a screw, which draws in the diagonal of the staff; thus embracing the four sides, and keeping the limb of the square perpendicular to the staff. The staff should be pointed with iron, to prevent wear. When the staff is fixed in the ground, on the station-line, the square answers the purpose of a cross-staff, and may, if desired, have sights fitted to it. The quadrant is three inches radius, of brass, is furnished with a spirit-level, and is fastened to a limb of the square, by means of a screw.

When the several lines on the limb of the quadrant have their first division coincident with their respective index-divisions, the axis of the level is parallel to the staff.

The first line next the edge of the quadrant, is numbered from right to left, and is divided into 100 parts, showing the number of links in the horizontal line, which are completed in 100 links on the hypothenusal line, and in proportion for any smaller number.

The second, or middlemost line, shows the number of links the chain is to be drawn forward, to render the hypothenusal measure the same as the horizontal.

The third or uppermost line, gives the perpendicular height, when the horizontal line is equal to 100."

USE.

"Lay the staff along the chain-line on the ground, so that the plane of the quadrant may be upright; then move the quadrant, till the bubble stands in the middle, and on the several lines you will have,—1. The horizontal length gone forward in that chain. 2. The links to be drawn forward to complete the horizontal chain. 3. The perpendicular height or descent made in going forward one horizontal chain.

The first two lines are of the utmost importance in surveying land, which cannot possibly be planned with any degree of accuracy without having the horizontal line; and this is not to be obtained by any instrument in use, without much loss of time to the surveyor. Whilst with this, he has only to lay his staff along the ground, and set the quadrant till the bubble is in the middle of the space, which is very soon performed. And he saves by it more time in plotting his survey, than he can lose in the field; for as he completes the horizontal chain as he goes forward, the offsets are always in their right places, and the field-book being kept by horizontal measure, his lines are sure to close.

If the superficial content, by the hypothenusal measure, be required for any particular purpose, he has that likewise, by entering in the margin of his field-book the links drawn forward in each chain, having thus the hypothenusal and horizontal length of every line.

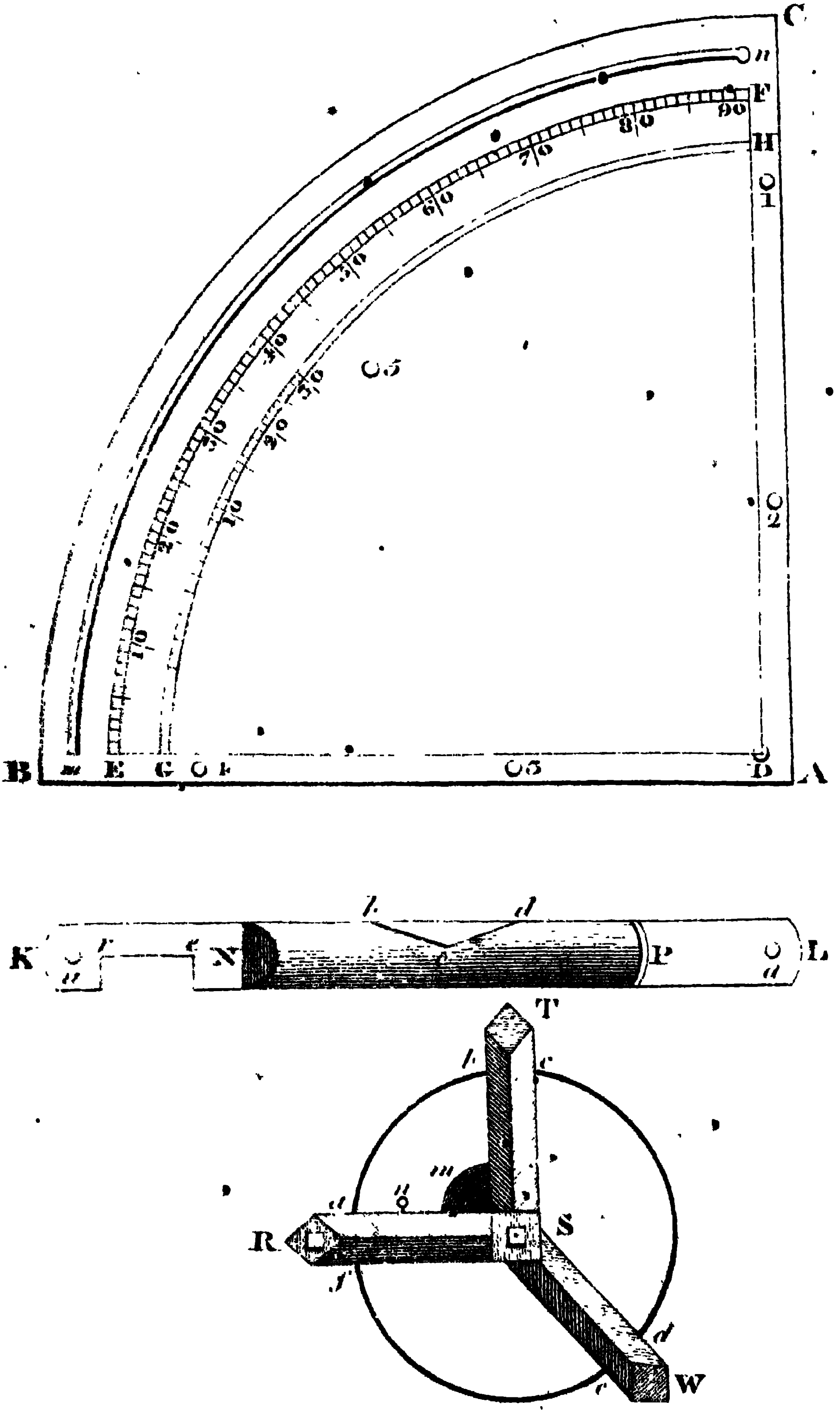
The third line, which is the perpendicular height, may be used with success in finding the height of timber. Thus, measure with a tape of 100 feet, the surface of the ground from the root of the tree; and find, by the second line, how much the tape is to be drawn forward to complete the distance of 100 horizontal feet; and the line of perpendiculars shows how many feet the foot of the tree is above or below the place where the 100 feet distance is completed.—Then, inverting the quadrant by means of sights fixed on the staff, place the staff in such a position, as to point to that part of the tree whose height you want; and sliding the quadrant till the bubble stands level, you will have on the line of perpendiculars on the quadrant, the height of that part of the tree above the level of the place where you are; to which add or subtract the perpendicular height of the place from the foot of the tree, and you obtain the height required."

Note 1.—If the real utility of Mr. King's Surveying Quadrant was better known among Land-Surveyors, it would be in more estimation; and would save them a great deal of trouble in measuring hilly ground. It may be had of Mr. W. Jones, price 1*l.* 18*s.*

2.—For the sake of those who may think Mr. King's Quadrant too expensive, I have invented one of a cheaper kind, which answers the same purpose in surveying, as Mr. King's, and may be used with equal facility. Any common mechanic will be able to make the wood-work; and after the lines are drawn upon the plate, an engraver will cut them for about five shillings. The whole expense of one which the Author had made for his own use, five inches radius, together with the offset-staff belonging to it, amounted to about twelve shillings.

Plate II.

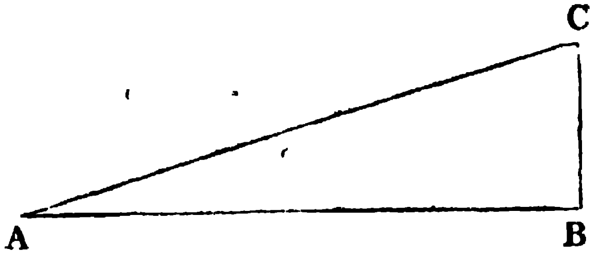
FACE of the QUADRANT, &c.



The following Table, by which the Quadrant may be constructed, shows the Number of Links to be drawn forward upon the Surfaces of Hills of different Altitudes, to complete the horizontal Chain.

Deg.	Min.	Lks.	Deg.	Min.	Lks.	Deg.	Min.	Lks.
5	43	½	41	44	34	53	28	68
8	4	1	42	12	35	53	43	69
11	22	2	42	40	36	53	58	70
13	52	3	43	7	37	54	13	71
15	57	4	43	34	38	54	27	72
17	45	5	43	59	39	54	41	73
19	22	6	44	25	40	54	55	74
20	50	7	44	50	41	55	9	75
22	12	8	45	14	42	55	23	76
23	27	9	45	38	43	55	36	77
24	37	10	46	1	44	55	49	78
25	43	11	46	24	45	56	2	79
26	46	12	46	46	46	56	15	80
27	45	13	47	8	47	56	28	81
28	42	14	47	30	48	56	40	82
29	35	15	47	51	49	56	53	83
30	27	16	48	11	50	57	5	84
31	16	17	48	32	51	57	17	85
32	4	18	48	52	52	57	29	86
32	49	19	49	11	53	57	40	87
33	33	20	49	30	54	57	52	88
34	16	21	49	49	55	58	3	89
34	57	22	50	8	56	58	15	90
35	37	23	50	26	57	53	26	91
36	15	24	50	44	58	58	37	92
36	52	25	51	2	59	58	48	93
37	28	26	51	19	60	58	58	94
38	3	27	51	36	61	59	9	95
38	38	28	51	53	62	59	19	96
39	11	29	52	9	63	59	30	97
39	43	30	52	26	64	59	40	98
40	14	31	52	42	65	59	50	99
40	45	32	52	58	66	60	0	100
41	15	33	53	13	67			

The Construction of the preceding Table.



In the right-angled triangle A B C, suppose the base A B to be 100, and the hypothenuse A C 100.5; then by Trig. as 100.5 : 1 :: 100 : .99502, the nat. co-sine of the angle B A C = 5^0 43′.—In the same manner, the rest of the angles are obtained, by different operations, accounting the hypothenuse 101 in finding the second angle, 102 in finding the third, &c.—

Now, from the preceding Table, it evidently appears, that if an instrument be constructed to take the altitude of a hill at every chain, if necessary, and a line traced upon the instrument, be so divided as to exhibit the number of links which the chain must be drawn forward, upon the surface of the hill, to complete the horizontal chain, according to the Table; it may be used with great advantage in surveying hilly ground.

The method of constructing the Quadrant, &c.

Procure a piece of soft sheet-brass, and upon it draw the lines A B and A C perpendicular to each other; and with a radius of five inches describe the quadrant B C.

Next, draw the lines D E and D F perpendicular to each other; and with four inches in your compasses for the first sweep, describe the double arc E F, which divide correctly into 90 equal parts or degrees. At a proper distance, likewise, from the arc E F describe the double arc G H, and the double arc m n. Of these, the latter must be cut through the brass by a file.

You must also procure a small glass tube, nearly filled with spirit, (generally called 'a spirit-level,') and a piece of sheet-brass K L, in length equal to A B, and in breadth rather exceeding the diameter of the tube; which call "the Index."

Then procure another piece of sheet-brass in the form of a semi-cylinder N P, large enough to admit the tube; and in it make the aperture b c d, in order to see the bubble.

Its edges solder to the index K L, so that the centre c may be exactly in the middle point between r and a ; r a rather exceeding D E; and a u being exactly equal to D m. The end N must also be closed up, by soldering a piece of brass upon it; and the end P left open, in order to admit the tube.

Next make a wooden quadrant, exactly the size of A B C, and in it a groove corresponding with the aperture m n, and large enough to admit a small screw-nail, with a square head and neck, so as to run, but not to turn round in the groove m n.

Then fix the plate A B C to the wooden quadrant, by the countersunk screws, 1, 2, 3, 4, 5; taking care first to insert the screw-nail above-mentioned, into the aperture m n, at a small hole made for that purpose at n.

Next, let the index K L be fixed upon the face of the quadrant, by a screw-nail passing through it at a, which must enter the quadrant exactly at the centre D. The nail in the aperture m n must likewise pass through the hole at u, and upon the end of this nail must be screwed a small nut, by which the end K of the index may be made fast at any altitude.

Now, to divide the arc G H, move the end K of the index toward C, until the line or edge r e, which must be exactly in the centre of the index, cuts the arc E F at 8° 4′, as per Table; and upon the arc G H, mark the first division. In the same manner, move the index until it cuts off 11° 22′, and there mark the second; continuing these operations, until you have made as many divisions as are necessary.—The divisions marked upon the arcs E F and G H, must then be properly cut and figured by an engraver.

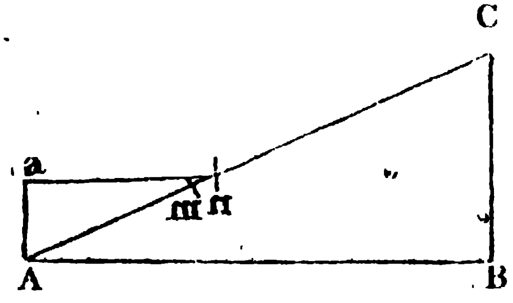
Next procure a wooden cross, R T S W, the three limbs of which must each be in length equal to A B or A C; and must form with each other three right angles, R S T, T S W, and W S R.

This cross must be made to slide upon an offset-staff by means of a square or rectangular aperture through the limb R S; and if a screw be fixed in the side of the limb at n, the cross may be fastened to the staff at any convenient height, by turning the screw against the side of the staff. As it will be somewhat difficult, however, on account of the limb R S being hollow, to make a joint at S sufficiently strong to keep the limbs at right angles with each other, they may be supported by means of the brackets, a b, c d, and e f. The quadrant A B C must then be fixed upon the square R S T, by means of two screws passing through the bracket a b, and one through the bracket m, so that the outside of the limb S R may coincide with A B, and the outside of the limb S T with A C.

To fix the tube or spirit-level correctly in the semi-cylinder N P, screw the index fast at no altitude, and place the edge A B of the quadrant upon a level table, which you may do by laying the tube upon it, and varying the position of the table until the bubble stands in the centre of the tube; then put the tube into the semi-cylinder N P, and fix it in such a manner that the bubble may be seen at c; after which, close up the end P with brass or putty.

Note.—If the quadrant be made the same size as that in Plate II, instead of five inches radius, as before directed, it will save much trouble in dividing; as the engraver may then follow the divisions given in the Plate; and the construction of this useful instrument will thus become very simple.

The Method of proving the Quadrant.



Let A C represent a strong plank, placed with one end against the perpendicular wall B C, and the other upon the horizontal plane A B. Lay an offset-staff, suppose of 12 links, upon A C, with one end at A and the other at m; then elevate the lower end, so that the staff a n may be parallel to A B. Measure the distance m n, which suppose to be 10.5 inches; then say, as 12 links is to 10.5 inches, so is 100 links to 87.5 inches, or 11 links.

Next, lay the edge A B of the quadrant upon the plank A C, and elevate the end K of the index, until the bubble stands at c; and if the index cut off 11 links, or nearly so, upon the arc G H, the quadrant is correct.

The Method of using the Quadrant.

Lay the staff, with the quadrant fixed to it, along the chain-line, so that the edge A B of the quadrant may come in contact with the ground; then elevate the end K of the index, until the bubble stands at C; and you will have the altitude of the hill upon the arc E F, and the number of links to be drawn forward to complete the horizontal chain, upon the arc G H. If you fix the bottom of the staff into the ground, upon the chain-line, the limbs S T and S W will serve as a cross, by which perpendiculars may be erected.

Note 1.—In using the quadrant, care should be taken to place it upon the even part of the surface of the hill.

2.—In measuring and reducing a line upon a hill, if it happen that the end of the chain reaches exactly to the station, at the end of the line, you must then deduct from the chain instead of drawing it forward. For example; if you find that the chain ought to be drawn forward 6 links, you must set down 94 instead of 100 links. Or, if the fiftieth link reach to the station, you must enter 47, instead of 50 links, &c.

3.—If you determine, by elevating the chain, and also by the Quadrant, the number of links to be drawn forward upon the surface of a hill, in order to complete the horizontal chain, you will seldom find them precisely the same because it is almost impossible to prevent the chain from forming a curve line, or to keep the staff perpendicular to the horizon. In every case, however, the conclusions of an instrument, constructed upon mathematical principles, are to be preferred.

Methods for finding the hypothenusal Measure of Hilly Ground.

This is by far the most difficult part of surveying; and, though we may approach toward, we can seldom obtain the true area of hills; because their surfaces are generally so irregular, that it is almost impossible to divide them into proper figures.—

If the land to be surveyed, lie in the form of a square, rectangle, trapezoid, trapezium, or triangle, against the side of a hill of a regular slope, take the dimensions and find the area in the same manner as if the figure lay upon a plane. But should it be required to find the area of a field (suppose in the form of a trapezium) in which there is a hill so situated as to affect the diagonal only; if the sides and diagonal be measured, and the figure laid down according to those dimensions, the perpendiculars will obviously measure less than they would have done, had the diagonal been reduced to a horizontal line; consequently, we cannot obtain the hypothenusal measure of such a field, by the common method of measuring trapeziums, or triangles.

In such cases, it is perhaps best, first, to measure the hill only. For this purpose, surround its base by station-staves, dividing it into an irregular polygon, each side of which must be measured. Then fix upon a convenient place, near the top of the hill, for a station; and between it and each station at the bottom, measure a line. Thus will the whole surface be divided into triangles, the areas of which must be found by laying down each triangle separately. Or, from the three sides, you may find the area of each triangle, as already directed.

Next, measure the remainder of the field, by dividing it into proper figures. Collect all the areas together, and their sum will be the area required.

When the land to be surveyed, ascends a hill on one side, occupies a plane upon the top, and descends on the other side;

you must divide it into such figures as will enable you to approach as nearly as possible to the true area.—

The foregoing directions may, perhaps, be found useful to a learner; but, in practice, much will always depend upon the Surveyor; he ought, therefore, to be very careful, whatever be the shape or size of the hill, to divide it into such squares, rectangles, trapezoids, trapeziums, or triangles, as are most likely to give him the hypothenusal measure.

Note 1.—In surveying a triangular field, of which one side passes over a hill, the other two being upon the horizontal plane of the base; it will be necessary to divide it into two triangles, by measuring a line from some part of the fence passing over the hill, to the opposite angle. Thus will two sides of each triangle be affected by the hill, the areas of which, found separately, will give the hypothenusal measure of the field.

2.—After making some experiments, and considering the subject very maturely, the Author is of opinion that the most correct method of finding the surfaces of hills in general, is to take the dimensions in such a manner that the areas of the different figures into which the hills are divided, may be found from the lines measured in the field, without having recourse either to the scale or plan. Hence, if the figures be rectangles, their lengths and breadths must be measured in the field; and if they be triangles, trapeziums, or trapezoids, their bases and perpendiculars must be measured in the field.

Several very experienced Land-Surveyors with whom the Author is acquainted, perfectly agree with him on this subject.

EXAMPLES.

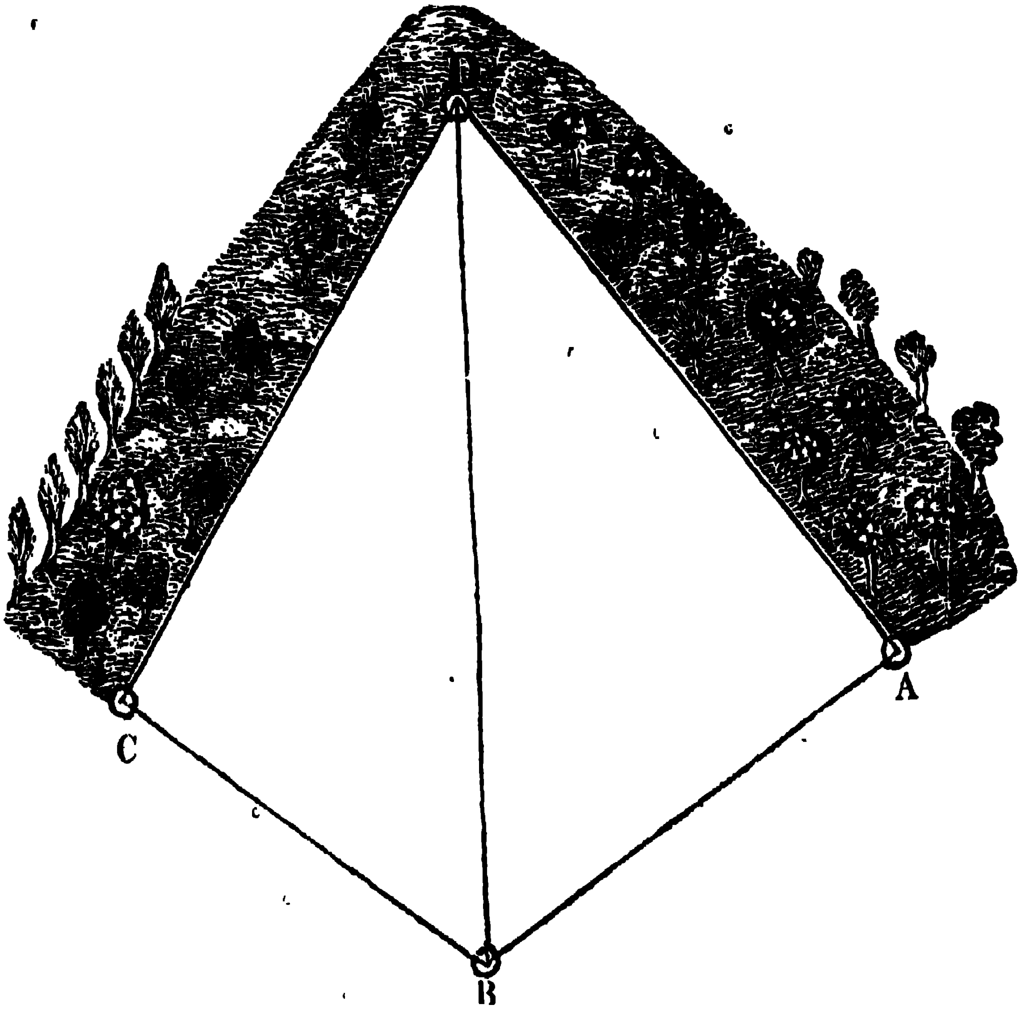
1. The length (or hypothenusal line) of a rectangular field, lying upon the side of a hill of regular ascent, is found to be 900 links, its breadth, 800 links, and the altitude of the hill 28° 21′; required the hypothenusal measure, and the length of the line that must be used in planning:

```
  900
   800
 7.20000
       4
  .80000
      40
32.00000   Area 7A. 0R. 32P.
```

Now, by the Table, page 174, we find that 12 links must be deducted from each chain; hence 9 × 12 = 108, which being taken from 900, leaves 792 links, the length of the line required.

Note.—If we multiply 792 by 800, we find the product 633600 square links, equal to 6A. 1R. 14P. the horizontal measure, which is less than the hypothenusal by 3R. 18P.

2. Let A B C D represent a field in the form of a trapezium, lying upon the side of a hill of an irregular ascent, the sides A B and B C being upon the horizontal plane of the base; required the horizontal and hypothenusal measures, from the following notes.



	110	B D	
	6	1154	
	12	1100	
	11	1000	
	12	900	
	10	800	
	11	700	
	10	600	
	8	500	
	9	400	
	7	300	
	8	200	
	6	100	
From	B,	go N.	Diag.
		A C	Diag. reduced for a proof-line.
		1300	
		R. off A.	
	78	D A	
	6	990	
	7	800	
	9	700	
	8	600	
	7	500	
	9	400	
	10	300	
	11	200	
	11	100	
		R. off D.	
	96	C D	
	5	1044	
	10	1000	
	11	900	
	12	800	
	11	700	
	9	600	
	10	500	
	8	400	
	7	300	
	6	200	
	7	100	
		R. off C.	
		B,C	
		800	
		R. off B.	
		A B	
		700	
Begin	at	A.	Range S. W.

The Operation of finding the horizontal Measure.

First, 700 + 1154 + 990 = 2844, the sum of the three sides, which being divided by 2, gives 1422.—From this number, deduct severally each side, and we obtain 722, 268, and 432, for the three remainders. Then, by multiplying the half sum and the three remainders continually together, and extracting the square root of the product, we obtain 344768 square links, the horizontal measure of the triangle A B D.

In a similar manner, we find the horizontal measure of the triangle B C D = 405559 square links; which, added to 344768, gives 750327 square links, equal to 7A. 2R. the horizontal measure of the trapezium A B C D.

The Operation of finding the hypothenusal Measure.

First, 1154 + 110 = 1264, the hypothenusal line B D; and 990 + 78 = 1068, the hypothenusal line D A. Then, 700 + 1264 + 1068 = 3032, the sum of the three sides, which being divided by 2, gives 1516. From this number, deduct severally each side, and we obtain 816, 252, and 448, for the three remainders. Then, proceeding as before, we obtain 373709 square links, the hypothenusal measure of the triangle A B D.—

In a similar manner we find the hypothenusal measure of the triangle B C D = 437917 square links, making jointly 821626 square links, equal to 8A. 0R. 34P. the hypothenusal measure of the trapezium A B C D, which exceeds the horizontal measure by 2R. 34P.

Note 1.—If you lay down the trapezium by the horizontal and hypothenusal lines respectively, and measure the perpendiculars by the scale, you will find the areas the same as those resulting from the foregoing operations.

2.—From these examples, it appears that the difference between the horizontal and hypothenusal measures of hilly fields, is often very considerable, and is deserving of particular notice. For instance; suppose the field, in the last example, to have been sown with wheat, and the owner to have sold the crop at the rate of 12*l.* per acre; the reapers have a claim upon the buyer for the hypothenusal measure; but if he makes his payment to the seller, by the same admeasurement, he will receive 8*l.* 11*s.* more than his due.

Practical Surveyors, however, in general, (as before observed,) return the horizontal measure, in surveying estates; whence few farmers, comparatively speaking, are charged for more; and ought not, therefore, when they sell a crop of corn, &c. to expect pay for the hypothenusal measure.

REMARK.

Since the publication of the first edition of this Work, the Author has consulted several eminent Land-Surveyors, and also Commissioners for Inclosures, in very extensive practice, in the West-Riding of Yorkshire, and in Cumberland, and Westmoreland, places noted for their hills; and they, without one exception, inform him that the horizontal measure of hilly ground is always returned, both by them, and by every practical Surveyor with whom they are acquainted.

Some late writers on Surveying contend very strenuously for the hypothenusal measure of hills; but the Author and his friends have no hesitation in saying, that those writers are very deficient in practical knowledge.

If we consider the earth as a perfect sphere whose diameter is 7957 miles, it is not necessary to take its curveture into consideration in surveying single Fields, Farms, or Lordships; for it is evident that the quantity of land even in the County of York, would form such a small spherical segment, that its convex surface would exceed the area of its base *extremely* little.

But we know that the hills upon the earth's surface are protuberances, and the valleys are cavities, both of which tend very materially to destroy the globosity of the earth; consequently it is evident that if the surfaces of all the mountains, hills, valleys, plains, oceans, seas, rivers, lakes, &c. &c. were measured separately, and then added together, the aggregate sum would greatly exceed the convex surface of the earth, measured as a perfect sphere ; hence the absurdity of the arguments of those writers who contend that all hills, however irregular, should be considered as bearing some similitude to a spherical segment, or to a hemisphere of the earth.

Now, as all hills are more or less irregular, the Author must confess that he is completely at a loss how to consider any hill as resembling the segment of a sphere : much less Snowdon and Plinlimmon, in Wales ; the Peak, in Derbyshire ; Whernside and Ingleborough, in Yorkshire ; Helvellyn and Skiddaw, in Cumberland ; the Cheviot Hills, in Northumberland ; and the Grampian Hills, and Ben Nevis, in Scotland ; to say nothing of the Pyrenees, the Alps, the Apennines, the Carpathian, the Koelen, and the Uralian Mountains, in Europe ; and the still higher mountains of Asia, Africa, and America.

But let us consider the subject on a less extensive scale ; and we shall still find that the advocates for the horizontal measure have the advantage, both with regard to practicability, expedition, accuracy, and justice.

It may be seen by inspecting the figure on page 177, that it requires no more posts, fixed at a certain horizontal distance from each other, to extend over the surface of a hill, than would be required for the horizontal plane of its base, if the hill were actually removed. It is also well known that no more trees, corn, &c. will grow upon the surface of a hill, than upon a plane equal in area to its base ; because the natural direction of all vegetation is perpendicular to the horizon ; hence the *injustice* done to the occupier, by returning the hypothenusal measure of hills.

Again, if the area of a field containing hills and valleys, either *natural* or *artificial*, be found from lines measured on the surface, and the field be sold by this measurement, and it be afterwards levelled by filling up the valleys with the hills ; it is evident that the buyer will not have the quantity of land for which he paid, if the field be re-measured ; hence the *injustice* of selling ground by the hypothenusal measure.

Lastly, it is evident that no more houses can be built upon a hill, than what could be built upon its base, if the hill itself were removed; because the walls of all houses are perpendicular to the horizon, and their eaves parallel to it; hence the buyer of building ground situated on a hill, forming an inclined plane, will be completely *defrauded*, if the ground be sold by the hypothenusal measure.

The same observations are equally just in all cases, relating to the measurement of hills, except for labour performed by the acre, which should always be calculated from lines measured upon its surface; because the spade, plough, sithe, or sickle, must inevitably pass over the whole hypothenusal area.

It may fairly be presumed that those writers who contend for the hypothenusal measure of hills universally, have never taken an *actual* survey of a mountainous district, where almost every line is affected by a hill, or they would have discovered the impracticability of the method which they recommend.

It is allowed by every one that the horizontal lines must be used, in order to produce a correct plan of a mountainous estate; but when a plan by the horizontal lines, and the area by the hypothenusal lines are wanted, it is evident the Surveyor must not only have two sets of lines, but also two different plans laid down from those lines.

One of those plans being laid down from the horizontal lines will exhibit the buildings, fields, rivers, &c. &c. in their natural situations; and the other being laid down by the hypothenusal lines, will shew the surfaces of the hills extended on a plane: hence their hypothenusal areas may be found.

Either this method must be followed, or the Surveyor must first take the horizontal lines for planning; and afterwards measure such lines on the surface of the ground, as will give him the hypothenusal area of the hills.

Every *professional* Surveyor will readily perceive, that both these methods must be very liable to errors, without any possibility of detecting them; for neither in planning from hypothenusal lines, nor in finding the area from dimensions taken in the field, can we have the least proof of the accuracy of the work.

And, if to these objections, we add the difficulties which will present themselves in taking the angle of elevation or depression of every hill, with a theodolite; the impossibility of doing this correctly, when a hill varies frequently in its inclination; the time that must necessarily be consumed in measuring two sets of lines; drawing two plans, &c. &c.; together with the inaccuracies which must arise from such a multiplicity of operations, devoid of proofs; it will manifestly appear that surveying, on these principles, is a *theoretical* dream, a *labyrinth* of perplexities, and a *system* of absurdities.

LAND-SURVEYING.

Part the Fifth.

THE METHOD OF SURVEYING AND PLANNING LARGE ESTATES, OR LORDSHIPS.

VARIOUS methods are adopted by different Surveyors, in taking the dimensions of large estates, or lordships; I shall, however, describe only four, which I conceive to be more accurate and practical than any other with which I am acquainted.

METHOD I.

Having made yourself acquainted with the form of the estate, either by actual examination, or by the assistance of a previous plan, select two suitable places, at the greatest convenient distance from each other, as grand stations; and measure a principal base, or what is generally called a "main-line," from one to the other, noting every hedge, brook, or other remarkable object, as you cross or pass it; taking offsets likewise to the bends or corners of the hedges that are near you.

Next, fix upon some other suitable place, towards the outside of the estate, as a third grand station; to which, from each extremity of the diagonal or main-line, or from two convenient points in it, lines must also be run.

These three lines being laid down, will form one large triangle; and in a similar manner, if necessary, on the other side of the diagonal or main-line, a second triangle may be formed.

The survey must then be completed by forming smaller triangles, on the sides of the former; and measuring such lines as will enable you, to obtain the fences of each enclosure, the boundaries of rivers, roads, lakes, &c. &c.; and prove the whole work.

Note 1.—If the estate be of a triangular form, three lines must be run, in the most convenient manner, so as to form the largest triangle possible; after which, other lines must be measured, offsets taken, &c. &c.; so that all the fences may be obtained, and the survey completed, as in Plate VIII.

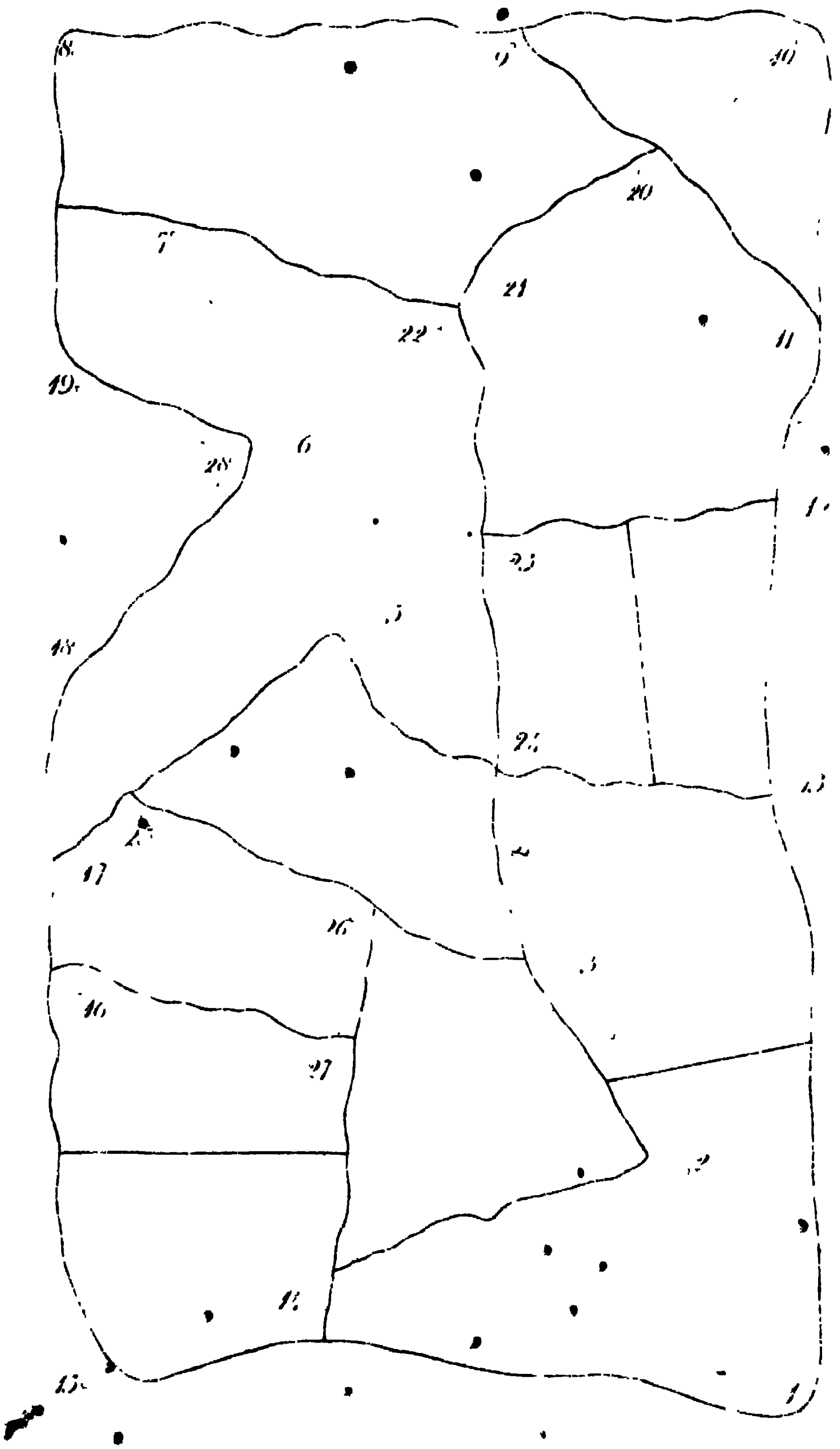
2.—When an estate is divided into two triangles, it is generally best to finish one of them before you measure any of the internal lines of the other, as in Plate III. Sometimes, however, it is more convenient and expeditious to run some lines in the second triangle before you have finished the first, as in Plate X.

3.—Estates similar to those in Plates III. and VIII., are very easy to survey, as they contain no impediments; but it is otherwise with estates like that in Plate X., where the windings of rivers, roads, and fences, make it necessary to run a great number of lines in order to obtain a correct plan of the whole estate, and the true area of every part.

4.—In extensive surveys, where two measurers are employed, it is best to consider the estate as divided into two distinct parts by the diagonal or main-line. Each Surveyor may then take a part, and make use of the diagonal as his base-line; and measure such other lines as are necessary to complete that part of the survey which he undertakes. By this means the lines of one Surveyor do not become entangled with those of the other; and the work is more expeditiously and more correctly performed, than if both the Surveyors were employed on the same side of the main-line.

5.—It is sometimes advisable to divide a very large estate in the following manner: Measure a line across the estate as near to the middle as convenient; and at right angles to this line, or nearly at right angles, measure another line, through the middle of the estate. These two lines being tied together by a connecting line measured from one to the other, will divide the estate into four parts, all of which may be measured separately by dividing them into triangles as before directed; and taking such dimensions as are necessary to complete the survey. This method is a very good one where three or four Surveyors are employed in measuring a large lordship, or even where one Surveyor only is employed; for the first two lines being considered as out-boundaries, the estate may be measured in four separate parts; and yet the whole will be so well connected by those lines, that it will be as easy to plan as a small survey.

Plan.



Scale 8 Chains to an Inch

6.—The method of surveying estates by dividing them into triangles, is exemplified and illustrated by Plates III. VIII. and X., the last two of which are actual surveys. The field-notes belonging to them are given in an engraven Field-Book; and Plates IX. and XI. are the finished plans.

7.—No notes are given to Plate III. as they would have occupied too many pages of copperplate; but the directions of all the lines may be easily ascertained by the following particulars: The first, or main-line, leads from + 1 to + 8; the second line from + 8 to + 10; and the third from + 10 to + 1; which three lines form the first large triangle. The fourth line extends from + 2 to + 15; and the fifth from + 15 to + 8; which two lines and part of the main-line form the second large triangle. The sixth line leads from + 9 to + 11; the seventh from + 20 to + 6; the eighth from + 7 to + 22; the ninth from + 21 to + 4; the tenth from + 24 to + 13; and the eleventh from + 12 to + 23; which complete the survey of the first triangle. The twelfth line extends from + 5 to + 17; the thirteenth from + 25 to the main-line, southward of + 3; the fourteenth from + 1 to + 14; the fifteenth from + 14 to + 26; the sixteenth from + 27 to + 16; the seventeenth from + 18 to + 28; and the eighteenth from + 28 to + 19; which finish the whole survey.

8.—The content of the estate may be found in the following manner: Measure the lines upon the plan, and take the necessary offsets, by a scale of 8 chains to an inch; and enter the dimensions in a Field-Book. From the dimensions thus obtained, draw a plan by a scale of 2 chains to an inch; then straighten the fences as directed in Part IV. or Part V.; and measure diagonals, perpendiculars, &c. from which compute the content of each field. The diagonals, perpendiculars, and contents may be entered in a Book of Castings, similar to those belonging to Plates VIII. and X.; and if you should not have a scale of 8 chains to an inch, any other scale will do just the same for practice.

9.—Taking the dimensions, &c. as directed in the last note, will be found of infinite service to the learner; as it will tend to make him very expert in entering the field-notes, laying down the lines, and casting the contents, which are no small acquisitions towards becoming a complete Land-Surveyor.

10.—At the particular request of several eminent Land-Surveyors, who very much approve of this Work, I have altered the method of entering the notes in the engraven Field-Book. In the first edition, the notes were entered from the right towards the left; in this edition they are entered from the left towards the right. Both methods are practised by different Surveyors; but it appears that the latter method is gaining ground.

11.—Some Surveyors represent the crossings of fences by lines drawn across the right and left-hand columns of the Field-Book; and others by lines crossing the middle column. The Author prefers the latter method; but every Surveyor will, of course, follow that of which he most approves.

12.—Many Surveyors enter their notes in a book about four inches and a half in breadth, and fourteen or fifteen in length, when open; and others prefer a book about eight or nine inches long, and seven or eight inches broad when open. (See the description of the Field-Book, Part II.; and also the engraven Field-Book belonging to Plates VIII. X. and XII.)

METHOD II.

Measure a main-line as nearly to one of the out-boundaries of the estate, as the curves in the hedges will permit; noting the crossings of fences, and taking offsets as before directed.

At a convenient distance, measure another a main-line parallel or nearly parallel to the first line, so that a number of fences running in that direction may be obtained; and from any two stations in the first line, measure lines to some station in the second main-line, thus forming a triangle; so will a station in the second main-line become determined or fixed.

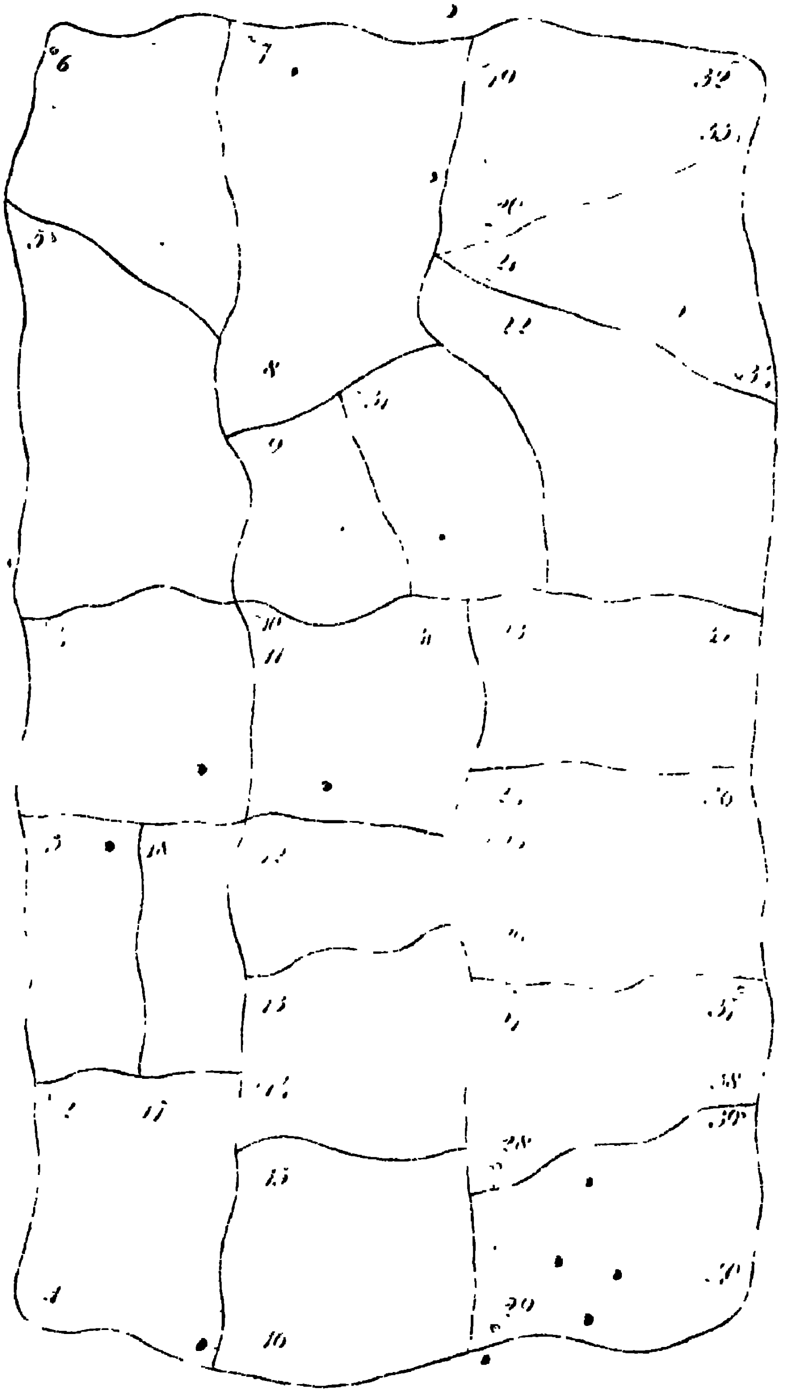
From the first main-line to the second, or from the second to the first, measure lines in order to obtain all the fences which run in that direction. The remainder of the fences of the enclosures contained between the first and second main-lines being obtained by running lines in the most convenient manner, you will have completed the dimensions of a portion of the estate, which may then be laid down.

Parallel or nearly parallel to the second main-line, and at a proper distance from it, measure a third; and proceed with the internal lines as before, and you will obtain the dimensions of another portion of the estate, which may also be laid down.

Carry on the survey in a similar manner, until you finish it.

PLATE IV.

Plan.



Scale 8 Chains to an Inch.

Note 1.—This method is illustrated by Plate IV. which displays the chain-lines and stations used in taking the survey. The field-notes are not given; but the following particulars exhibit the directions of all the lines: The first main-line leads from + 1 to + 6; the second from + 6 to + 7; and the third line, or second main-line, from + 7 to + 16. The fourth line extends from + 16 to + 1; the fifth or tie-line from + 16 to + 2; the sixth from + 2 to + 14; the seventh from + 17 to + 18; the eighth from + 12, through + 18, to + 3; the ninth from + 4 to + 10; and the tenth line leads from + 8 to + 5; thus all the fences between the first and second main-lines are obtained.

The eleventh line, or third main-line leads from + 19 to + 29; the twelfth from + 29 to + 16; the thirteenth from + 29 to + 15; the fourteenth from + 15 to + 28; the fifteenth from + 26 to + 13; the sixteenth from + 12 to + 25; the seventeenth from + 23 to + 11; the eighteenth from + 30 to + 31; the nineteenth from + 9, through + 31, to + 22; and the twentieth from + 7 to + 19, which complete the survey between the second and third main-lines.

The twenty-first line, or fourth main-line, extends from + 32 to + 40; the twenty-second from + 40 to + 29; the twenty-third from + 40 to + 28; the twenty-fourth from + 28 to + 38; the twenty-fifth from + 37 to + 27; the twenty-sixth from + 34 to + 36; the twenty-seventh from + 35 to + 23; the twenty-eighth from + 34 to + 21; the twenty-ninth from + 20 to + 23; the thirtieth from + 32 to + 19, which finish the whole estate.

2.—In order to practise the learner, a Field-Book may be formed, and the content of the estate found in the same manner as directed in Note 8, Method I.

3.—Some writers on Surveying instruct their pupils to measure main-lines through the estate to be surveyed; and upon these, by the help of a cross, to erect perpendiculars to the opposite angles, and curved fences; and upon these perpendiculars, again, if necessary, to erect other perpendiculars; thus dividing the whole estate into right-angled triangles and trapezoids.

The method here described is extremely tedious, as many of the perpendiculars will be 12 or 15 chains in length, when the fields are large; and where the fences are much curved, it becomes almost impracticable, in consequence of the great number of offsets or perpendiculars that must be taken, in order to obtain a correct plan of the estate.

Besides, when the fence to which perpendiculars must be erected, is at a considerable distance from the base-line, it will be necessary for an assistant to walk along, by the fence, in order to point out to the Surveyor, the angles and curves to which offsets ought to be taken: and if there be a crooked fence on each side of the base-line, two extra helpers will be necessary, if the Surveyor intends to perform his work with expedition. Hence we see that this, process of measuring, not only subjects the Surveyor to a great deal of extra trouble, but also to a very considerable, unnecessary expense.

This method I have never followed in measuring estates; neither have I ever seen it followed by any *experienced* Surveyor. On the contrary, all with whom I am acquainted, consider it quite preposterous.

METHOD III.

An estate of four sides may frequently be conveniently surveyed as follows: Measure four lines in such a manner that offsets or insets may be taken to the four out-boundaries of the estate; and tie the first and fourth lines together by a diagonal or tie-line measured from one to the other, at the distance of five, six, or more chains from the angular point, according to extent of the survey; thus you will be enabled to lay down the first four lines, and also the out-boundaries of the estate.

Next proceed to obtain the internal fences, by measuring lines in the most convenient manner; some of which must be run from the first to the third, or from the second to the fourth line, or in some other proper direction, so that they may become proofs and fast-lines, into which other lines may be run with propriety.

In thus proceeding, it is evident that a great deal will always depend upon the dexterity and ingenuity of the Surveyor, as no directions can be given that will suit every particular case to be met with in practice.

Note.—This method of surveying an estate, is exemplified by Plate XII. the field-notes of which are contained in the engraven Field-Book, given with this Work. It is also illustrated in my Mensuration, by Plate III. which is the plan of an estate lying in the Township of Farnley, in the Parish of Leeds. With this plan there is likewise given an engraven Field-Book, and also a book of dimensions, castings, and areas.

METHOD IV.

The method which I here intend to describe, is a compound of all the foregoing methods of surveying with the chain; for as there are never two estates to be met with which are exactly alike, sometimes one method claims the preference, and sometimes another; but a skilful Surveyor will always adopt that by which he can take his dimensions and proofs with the greatest accuracy, by the fewest lines.

If an estate be in the form of an irregular polygon of five, six, or more sides, and the fences very crooked, such an estate may generally be most easily surveyed by dividing it into triangles, as in Method I.; but if many of the fences of the different enclosures run a considerable way in the same direction, and the fields in general pretty neat trapezium, it is commonly more eligible to proceed as directed in Method II.

Sometimes an estate varies so much in its shape, that all the methods before described may be used with propriety and advantage; and it frequently happens that an ingenious Surveyor adopts methods, in particular cases, entirely new to himself; care, however, must always be taken to make one line depend upon another, throughout the whole survey, so that when you come to lay it down, you may find no lines whose positions are undetermined.

Note 1.—Whatever method of surveying is adopted, the field-notes must be entered in a similar manner to those given in the engraven Field-Book. Some Surveyors place the letter S, against straight fences, in the Field-Book, to distinguish them from those that are crooked; but they may be very well denoted by drawing straight, or crooked lines, as the case requires.

2.—The estates given in this Work, as examples, are not very extensive, in consequence of the serious expense that attends large plates, and the great inconvenience of folding them in books; but it may be remarked, that the foregoing methods of surveying are applicable to estates of all sizes; even to those of many thousand acres.

MISCELLANEOUS INSTRUCTIONS.

1. When you have an estate to survey, never begin your work too hastily. Walk over the estate; examine it minutely; and observe by which of the foregoing methods it can be most easily measured. Next determine upon that point at which it will be most convenient to begin; and never omit to take the range of the first line with a compass. If you do, it will be impossible for you to lay it down, in its true position, upon the plan.

2. In measuring your main, or any other chain-line, put down stations at every place to which you apprehend it may be necessary to run lines, in order to complete the survey.

3. You may sometimes put down a station, whether you see any particular use for it or not; because it may become serviceable in correcting an error, should one be committed; and, if it be not used, it will be immaterial.

4. In measuring your internal lines, it will give you the least trouble to run them from one station to another, if you can make it convenient; if not, you must run them from, and continue them to some chain-line, and measure the distance upon that line, to the nearest station, which may be entered in the field-book, thus; run upon 1 line, 30 links S. of + 1, &c.

5. The place where you run upon, or cross a chain-line, may be easily ascertained by setting up poles at two of the nearest stations in that line; the crossing will be at the place where you are in a direct line with these poles, which may be represented by marks cut in the ground, pointing out the directions of the lines.

6. In ranging the poles, there must be one fixed at the station from which you intend to depart, and another at the place toward which you direct your line, if there be no natural mark, as a tree, the corner of a house, &c. Then, in a straight line with these marks, put down poles at the distance of 4, 6, or 10 chains from each other, accordingly as impediments may render them necessary.

7. When you are measuring a line across a valley, you must proceed forward until you are likely to lose sight of the station to which you are going; then, let your assistant take a pole to the other side of the valley, and direct him to place it exactly in the line which you are measuring, so as to be seen from the bottom of the valley; to this you may continue your line, and thence to the end.

8. When the stations between which you wish to run a line, are so far distant that you cannot see from one of them to the other, or when your view is obstructed by an elevation between them, you must then, accompanied by your assistant, go to the place whence you can distinctly see both; and turning face to

face, at a little distance, direct each other to the right or left, until you are both in a right line with the stations; then, one of you putting down a pole, the line will be correctly found. If the line, however, be so long, that you cannot possibly find it by the above methods, it must be ranged at random; but, in this case, you should be extremely careful that your pole-ranger keeps one pole in a direct line with another, which he may accurately effect by always having, at least, two behind him.

9. In measuring a line which passes over a hill, you must attend to the directions given in Part IV. in the Method of measuring Hilly Ground; but you will not always find your lines to meet correctly, in surveying mountainous estates.

10. When a river runs through the estate, it will be necessary to continue some of your lines across the river, in order to tie the whole survey together.

11. Rivers, large brooks, public roads, and common sewers, should not be included in the area, but only delineated upon the plan. If however, their areas be required, they should be given separately.

12. Marshes, bogs, heaths, rocks, &c. belonging to the estate, should be distinctly represented upon the plan; and their measurements separately returned.

13. You will generally have an opportunity of representing some part of each hedge in your field-book; and you may denote on which side of the ditch the fence stands, by drawing a small bush, or by specifying it in writing.

14. In surveying estates, the crossings of fences must be taken at the outer extremities of the ditches, and not at the roots of the quickwood; because the ditch, and not the fence, is the division line between adjoining fields; but in measuring enclosures which are separated by walls, the case is generally different, as the walls most commonly form the lines of division. It may also be observed, that the ground upon which a wall stands must be measured with the field to which the fence belongs, and as walls are generally broader at the bottom than at the top, it is necessary to attend to this circumstance in taking the dimensions.

15. When the Surveyor finds it convenient, he may put down stations at the outer extremities of the ditches; and in planning, these stations will, of course, fall upon the black lines, because they always represent the boundaries between adjoining fields. This accounts for several of the stations appearing on the black lines, of the rough plans, in Plate VIII. X. and XII.

16. In taking a survey, you must enter in your field-book the name of each field, or of its proprietor or occupier; or you may make such remarks, as will enable you to distinguish the fields from each other, &c. and after the plan is drawn, acquire, from persons acquainted with the estate, every necessary additional information.

17. When hedges obstruct your sight, in running the lines, it will be necessary to cut down part of their tops, in order to see the poles.

18. If it should happen that you measure a line for which you have no particular use, it will serve as an additional proof: it is evident that you had better measure too many lines than too few.

19. In taking a survey, you ought to observe to whom the adjoining ground belongs; and specify the same upon the plan.

20. Some of our Practical Surveyors use only nine arrows. When the leader has advanced ten chains, the follower goes up to him, and places his foot or offset-staff at the end of the chain, instead of the tenth arrow; but in this method I do not perceive any particular advantage.

GENERAL RULES FOR PLANNING LARGE SURVEYS.

The method of laying down a large survey, from the field-book, may easily be acquired by practice; but as the least appearance of difficulty generally discourages a learner, it is presumed that the following directions may be found acceptable.

Having provided a sheet of drawing-paper of a proper size, trace with a pencil, a meridian, or north and south line, in such a manner that your first station may be in some convenient point in this line. Then, from your first station, draw your first or main-line, making its proper angle with the meridian line, which you may then take out with Indian rubber.

Next, take separately in your compasses, your second and third lines, or any two more convenient ones, forming a triangle with the main-line; and placing one foot of your compasses in the proper centres respectively, describe arcs intersecting each other. Thus will you have three points, from which to form a triangle.

In the same manner proceed with each triangle formed upon the main-line, (or upon any other line,) proving your work as you advance, until all the triangles are laid down; and if you find all your lines correctly meet, it will be an infallible proof of the accuracy of the work.

The chain-lines being thus laid down, next prick off the crossings of fences, and draw lines in their proper situations, from one crossing to another, to represent the straight fences.

The curved fences must be formed by laying down the offsets, as already directed.

When the whole survey is planned, all the fences must be drawn with Indian ink, the chain-lines and offsets dotted, and the stations, gates, stiles, &c. marked in their proper places: the sheet will then represent what is called a "Rough Plan."

Note 1.—When a fence represents a chain-line, it must not be dotted.

2.—Practical Surveyors never dot their chain-lines or offsets, but only mark their stations upon the plan; but it is more satisfactory to a learner, to be able to see all his chain-lines at a single view.

3.—In taking a very large survey, it is necessary that the work be laid down, and proved every night; for if an error be committed, and the survey continued two or three days before it be discovered, the detection, in the field, will probably be attended with a great deal of trouble.

4.—In laying down large surveys, it sometimes happens that one sheet of paper will not contain the whole; in this case, two or more, must be pasted together.

5.—When you have to lay down a line exceeding the length of your scale, draw a line with your pencil, in some convenient place upon the plan; and upon it, at two or more operations, prick off the distance in question, which you may then take in your compasses.

6.—"Beam compasses, which are very useful in drawing large circles, taking great extents, &c. consist of a long straight beam or bar, carrying two brass cursors; one of them fixed at one end, the other sliding along the beam, with a screw to fasten it on occasionally. To the cursors may be screwed points of any kind, as of steel, pencils, &c. To the fixed cursor is sometimes applied an adjusting or micrometer screw, by which an extent may be obtained to a very great nicety."—See Hutton's Mathematical Dictionary, I. 315.

DIRECTIONS FOR PLANNING THE ESTATE IN PLATE VIII. FROM THE DIMENSIONS IN THE ENGRAVEN FIELD-BOOK.

It appears by the first page of the field-book, that the range of the first line is N. N. W.; and by referring to the compass, Plate I. we find that the angle which this line makes with the meridian line, is 22° 30′.

By Prob. 23, Part I. lay down a line making an angle of 22° 30′ with the meridian line; and by a scale of four chains to an inch, prick off 2802 links, from cross or station (+) 1, to + 3; and you will thus have part of the first line.

Now, as the third line could not be run to + 1, in consequence of a large quickwood hedge intervening too far to be cut down; it was necessary to produce the first line 30 links southward, in order that the first three lines might form a triangle; consequently, the first line must be continued 30 links southward from + 1, in laying down the plan; and this continuation completes the first line.

Take the second line, 3075 links, in your compasses, and with one foot in + 3, describe an arc, and with 3270 links, the third line in your compasses, and one foot in a point 30 links south of + 1, describe another arc, intersecting the former in + 6; join these three points by drawing lines from + 3 to + 6, and from + 6 to the above-named point; and you will thus form the triangle 1, 3, 6.

Next, prick off stations 2, 4, 5, 7, and 8; and lay your plotting-scale from + 2 to + 8, and if it measure 1046, as in the field-book, line six, you have good reason to conclude that your dimensions are thus far correctly taken and laid down.

Also, mark off + 10, try its distance from + 4; likewise examine the distance from + 5 to + 7; and if you find both these lines the same as in the field-book, your survey is evidently correct.

With the fourth line, 257, in your compasses, and one foot in + 1, describe an arc; and with the fifth line, 1004, as a radius, and + 2, as a centre, make another arc cutting the former in + 9; hence you have three points by which to form the triangle 1, 9, 2.

Lastly, complete the rough plan by pricking off, and drawing all the straight fences; laying down the offsets; making the gates; numbering the fields, &c. &c. as in the Plate.

DIRECTIONS FOR PLANNING THE ESTATE IN PLATE X. FROM THE DIMENSIONS IN THE ENGRAVEN FIELD-BOOK.

WE find from the fourth page of the field-book, that the first line ranges W. b. N. $\frac{1}{2}$ W., making an angle with the meridian line, $84^{\circ}\ 22\frac{1}{2}'$.

By Prob. 23, Part I. draw a line, making an angle of $84^{\circ}\ 22\frac{1}{2}'$ with the meridian line; and by a scale of four chains to an inch, prick off 5445 links, from + 1 to + 12; and you will thus obtain the first line; upon which prick off stations 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11.

With 900, part off the third line, in your compasses, and + 1, as a centre, describe an arc; and with 625, the fourth line, as a radius, and one foot in + 2, intersect the former arc in + 22. From + 2, draw a line to + 22; and from + 1, through + 22, draw the third line, equal to 1360, and you will obtain + 23.

With the second line, 3790, in your compasses, and + 12, as a centre, describe an arc; and with 925, part of the fifth line, as a radius, and + 23, as a centre, describe another arc, cutting the former in + 21. From + 23, through + 21, draw a line equal to 2090, and you will thus obtain the fifth line, and also stations 24, 25, and 26.

Draw a line from + 12 to + 21, and you will have the second line; and also stations 13, 14, 15, 16, 17, 18, 19, and 20; and draw another from + 26, to a point in the first line, 295 W. of + 10; and you will obtain the sixth line; and likewise stations 27 and 28.

With 2325, the twenty-sixth line, in your compasses, and + 3 as a centre, describe an arc; and with 1210, part of the twenty-seventh line, as a radius, and one foot on the first line, 150, W. of + 7, describe another arc, cutting the former in + 33. Draw a line from + 3 to + 33; and from + 33, through the intersection of the first line, draw the twenty-seventh line, equal to 2040, and you will obtain + 43.

Next, with 446, the seventh line, in your compasses, and + 12, as a centre, describe an arc; and with 2528, the eighth line, as a radius, and + 33, as a centre, describe another arc, cutting the former in + 29. Draw lines from + 12 to + 29, and from + 29 to + 33, and you will obtain stations 30, 31, and 32; and also draw the ninth line from + 32, through + 8, and + 16, to + 27, and you will have stations 34, 35, 36, and 37.

Join stations 11 and 13, and you will obtain the 10th line; 28 and 30, and you will have the 11th line; 37 and 18, and you will obtain the 12th line; 19 and 25, and you will have the 13th line; 38 and 20, and you will obtain the 14th line; 20 and 39, and you will have the 15th line; 24 and 39, and you will obtain the 16th line; 39 and 19, and you will have the 17th line; 17 and 27, and you will obtain the 18th line.

From + 31, through + 9, draw the 20th line, equal to 1175, and you will obtain stations 40 and 41; join 36 and 40, and you will have the 19th line; and from + 41, through + 34, draw a line to a point in the 1st line, 72 E. of + 7, and you will obtain the 21st line.

Draw a line from + 35 to + 43, and you will have + 42, and the 23rd line; and join + 42 and 36, and you will obtain the 22nd line. Draw a line + 23 to the first line, 115 E. of + 5, and you will obtain + 45, and the 29th line; from + 43 to + 45, and you will have + 44, and the 24th line; from + 3 to + 45, and you will obtain the 25th line.

Lastly, complete the rough plan, by pricking off, and drawing all the straight fences; laying down the offsets; making the gates; forming the bases of buildings; shading the river; numbering the fields; &c. &c. as in the Plate.

Note 1.—Hot-pressed drawing-paper is best for plans, because its surface is very smooth; consequently, fine lines may be drawn upon it. Parchment and vellum are more durable than paper; hence they are generally used for planning estates belonging to gentlemen who are desirous that the plans may be handed down to their posterity. Vellum exceeds parchment in durability; and it may be necessary to remark, that when either of them is used for planning, it must first be rubbed with clean flannel dipped in the best Paris whiting. This operation clears its surface from grease; and facilitates the movements of the pen.

2.—In damp weather, paper expands, and in dry weather, it contracts; consequently, if a plan be drawn when the paper is in a moist state, and the content be not found till after it has become perfectly dry, the diagonals and perpendiculars will measure too little, and will of course give the area too little also; but if the plan be drawn when the paper is dry, and the area be found after it has expanded by a change in the atmosphere, the diagonals and perpendiculars will measure too much, and will consequently give the area too much likewise. Hence the necessity of having the paper in the same state of temperature when you find the area, that it was in when you laid down the chain-lines, offsets, &c.

3.—The most expeditious method of laying down crooked fences, is by means of an offset-scale, which must be used with the plotting-scale in the following manner: Lay one edge of the plotting-scale close by the base-line, and bring the end of the offset-scale in contact with the edge of the plotting-scale, so that the edges of the scales may form a right-angle; then by the edge of the offset-scale, prick off, in its proper situation, the first offset, with a pencil finely pointed. Keep the plotting-scale firm, and slide the offset-scale to the place of the next perpendicular, which prick off as before; and thus proceed until all the offsets are finished.

4.—Brookman and Langdon's prepared lead pencils, of different degrees of hardness, for the use of Engineers, Architects, Land-Surveyors, and Artists, are now in high repute among Draftsmen. The pencils marked H. H. very hard, and H, not quite so hard, are well adapted for the use of Land-Surveyors; as they bear pointing better than any other, and produce much finer lines.

TO COMPUTE THE CONTENTS.

After the whole survey is laid down, Practical Surveyors straighten the crooked fences of each field, as directed in Part IV.; and then divide the fields into trapeziums and triangles, and take such dimensions, by the scale, as are necessary to find the separate area of each field. They then collect all the areas into one sum; afterward find the area of the whole survey, as if it were a single field, and if it appears to be equal, or nearly equal, to the sum of the separate areas, previously found, they justly infer that their survey is correct.

Note 1.—Those who do not approve of finding the area by the method of casting, may make use of the offsets taken in the survey, where convenient; and if more be wanted, they may be measured by the scale; for in measuring a number of small parts by it, some will probably be taken a little too large, and others a little too small, so that, in the end, they will nearly counterbalance each other.

2.—Practical Surveyors generally lay down their lines by a scale of 4 chains to an inch, when their surveys are very large; and in computing the contents, they measure the bases and diagonals by the same scale, but the perpendiculars by a scale of 2 chains to an inch; consequently, the product of the base and perpendicular of a triangle, will be its area. To treat small surveys, in a similar manner, by a scale of 2 chains, and of 1 chain to an inch, must, of course, be very correct.

3.—When the survey is not very large, the content of each field may be set down in some convenient place upon the plan. In other cases, it may be entered within the field itself. Some gentlemen, however, prefer having the areas of their estates given in a book of particulars, containing numbers, or letters of reference corresponding to those upon the plan.

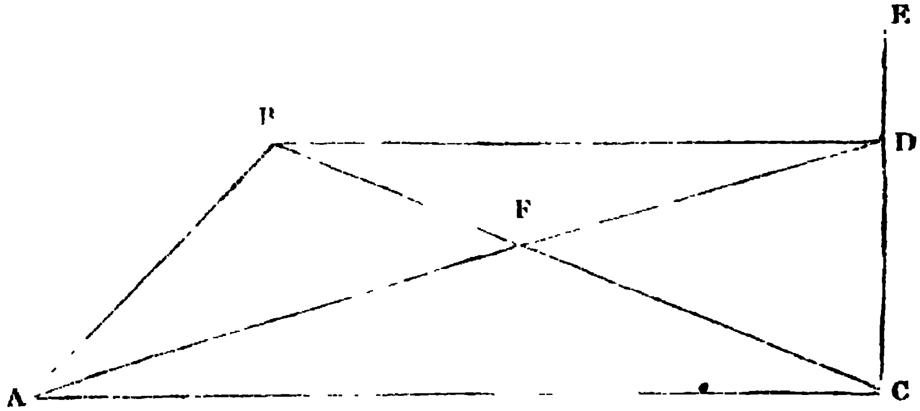
4.—As some Surveyors prefer a parallel ruler to a lantern-horn, or a bow of whale-bone and silk, for reducing crooked fences to straight ones, I have in the following Problems, given the method of using that instrument, in order that this work may meet the approbation of all classes of scientific readers; and be rendered as useful and practical as possible.

5.—When there are no dimensions given in the following Problems, the figures may be measured by a scale, and then laid down in the learner's book; after which, the operations by the parallel ruler may be performed. Or, for practice, figures may be made at pleasure; and the necessary equalising lines drawn, according to the subsequent directions.

THE USE OF THE PARALLEL RULER IN REDUCING CROOKED FENCES TO STRAIGHT ONES, IN ORDER TO FIND THE AREAS OF FIELDS BY THE METHOD OF CASTING.

PROBLEM I.

To draw a right Line A D, from the Point A, through the Line B C, so that the Quantities on each Side of the Line A D, may be equal.



Draw, with your pencil, a temporary line C E, at pleasure; then your ruler being closed, lay it from C to A; hold the side, that is next to you, fast; open the other to B; make a mark with your pencil upon the temporary line C E, where the edge of the ruler cuts that line, as at D; draw a line from A to D, and the quantities on each side of this line will be equal; that is, the triangle A B F will be equal to the triangle C D F.

DEMONSTRATION.

Draw the line A C, and also the line B D, which is evidently parallel to A C; then by Theo. 6, Part I. the triangle A B C is equal to the triangle A C D; take away the triangle A C F, which is common to both, and there remains the triangle A B F equal to the triangle C D F.

Note 1.—The solutions of all the following Problems are founded upon the foregoing demonstration.

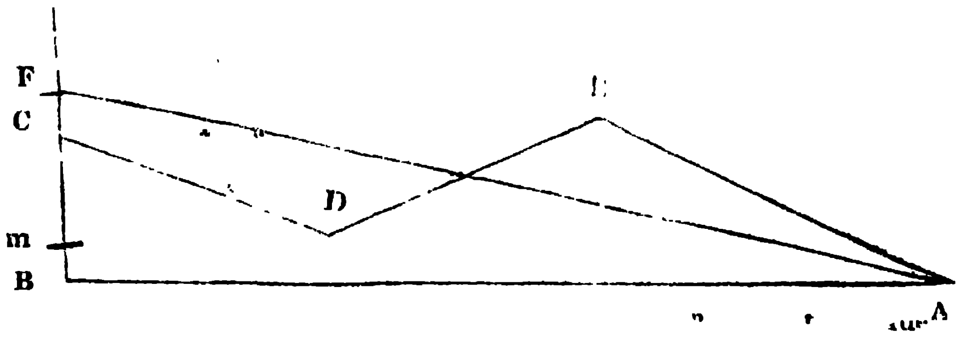
2.—If it had been required to draw the equalising line from the angle C, through the line A B, the temporary line must have been made from the angle A.

3.—All the operations must be performed with the utmost care and accuracy; and if, at any time, the ruler be suffered to slip, the work must be repeated, or it will not be correct.

4.—When an error has been committed, it may frequently be discovered by the *eye*, after the equalising line is drawn.

PROBLEM II.

Let the irregular figure A B C D E A represent an Offset taken in surveying a Field; it is required to draw a right Line from the Angle A, so as to reduce the Figure to a right-angled Triangle.



Produce the perpendicular B C, for a temporary line.

Lay your ruler from C to E; bring it down in a parallel position to D; and make a mark upon the line B C, where the edge of the ruler intersects that line, as at m.

Lay your ruler from m to A; move it in a parallel direction to E; and make a mark upon the line B C, close by the edge of the ruler, as at F.

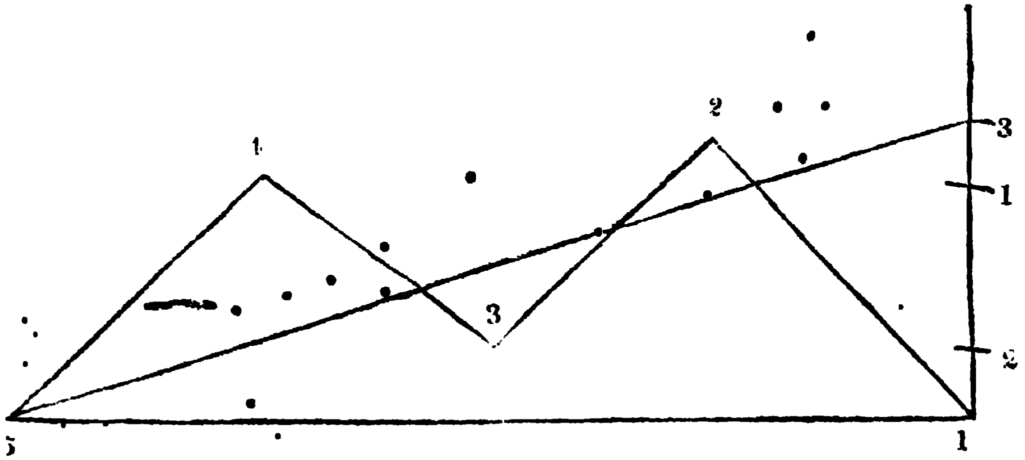
Draw a line from A to F; and the triangle A B F will be equal to the irregular figure A B C D E A; hence the area may be found by multiplying the base A B, by half the perpendicular B F.

Note 1.—In practical operations, the equalising and temporary lines must be made with a pencil finely pointed; and effaced with Indian rubber, after the area is found.

2.—If perpendiculars be let fall from the angles E and D, upon the base A B; the necessary dimensions taken by a scale; and the area of the irregular figure A B C D E A obtained by the rules for triangles and trapezoids, it will be found equal to the area of the right-angled triangle A B F; great care, however, must be used to make the lines very fine, and to take the dimensions of all the figures with the utmost accuracy.

PROBLEM III.

It is required to reduce the Offset 1, 2, 3, 4, 5, to a right-angled Triangle, by drawing an equalising Line from the fifth Angle through the irregular Fences.



Perpendicularly to the base, and from the first angle, draw a temporary line.

Lay your ruler from the first to the third angle; move it in a parallel position to the second angle; and mark the temporary line at number 1.

Lay your ruler from number 1, to the fourth angle, bring it down in a parallel direction to the third angle; and mark the temporary line at number 2.

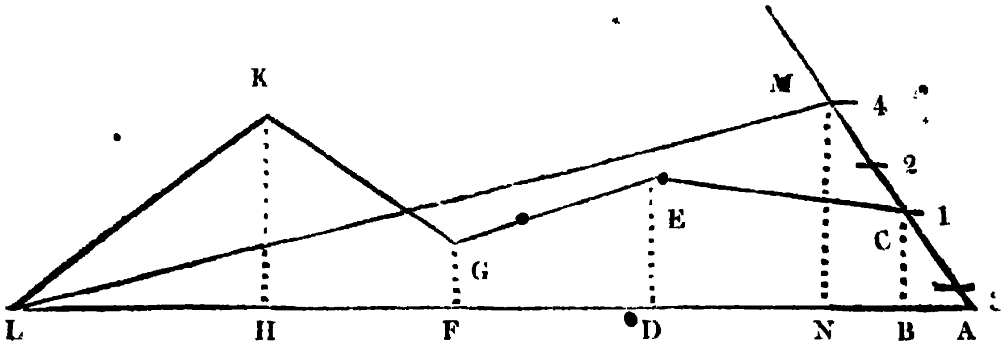
Lay the ruler from number 2, to the fifth angle; move it parallel to the fourth angle; and mark the temporary line at number 3.

Draw a line from the fifth angle to number 3; and 5, 1, 3, will be the right-angled triangle required; hence the area of the irregular offset may be found by multiplying the base 1, 5, by half the perpendicular 1, 3.

PROBLEM IV.

It is required to lay down a right-line Offset, from the following Dimensions; to reduce it to a Scalene Triangle by the Parallel Ruler; and to find its Area both by the Method of Offsets and Casting.

	A L	
	1500	0
H	1100	300 K
F	800	100 G
D	500	200 E
B	100	150 C
	000	0
From	A, go	West.



Having laid down the figure; produce the side A C, at pleasure, for a temporary line.

Lay the ruler from the first angle A, to the third angle E; move it parallel to the second angle C ; and mark the temporary line at 1, which, in this case, is at the second angle, because the side A C, is the temporary line.

Lay the ruler from 1, to the fourth angle G ; move it parallel to the third angle E ; and mark the temporary line at 2.

Lay the ruler from 2, to the fifth angle K ; move it parallel to the fourth angle G ; and mark the temporary line at 3.

Lay the ruler from 3, to the sixth angle L ; move it parallel to the fifth angle K ; and mark the temporary line at 4.

Draw a line from the sixth angle L, to number 4 (M) ; and A L M will be the scalene triangle required.

Computation of the Area by Offsets.

Here 150 × 100 = 15000, twice the area of the triangle A B C; 150 + 200 × 400 = 350 × 400 = 140000, twice the area of the trapezoid B D E C ; 200 + 100 × 300 = 300 × 300 = 90000, twice the area of the trapezoid D F G E; 100 + 300 × 300 = 400 × 300 = 120000, twice the area of the trapezoid F H K G ; and 400 × 300 = 120000, twice the area of the triangle H L K ; then 15000 + 140000 + 90000 + 120000 + 120000 = 485000, twice the area of the whole offset; and 485000 ÷ 2 = 242500 square links = 2A. 1R. 28P. the area required.

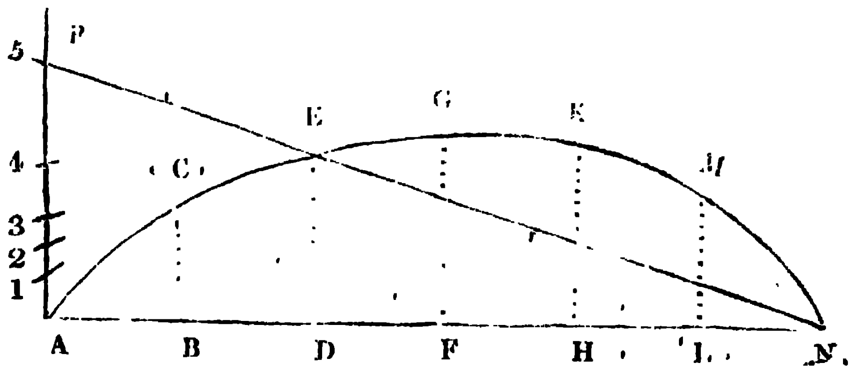
Computation of the Area by Casting.

From the angle M, let fall the perpendicular M N, which you will find to measure 323 links; then $\frac{323 \times 1500}{2} = \frac{484500}{2} =$ 242250 square links = 2A. 1R. 27.6P. the area required; which differs only four-tenths of a perch from the area found by offsets.

PROBLEM V.

Lay down a curve-line Offset from the following Dimensions; reduce it to a right-angled Triangle by the Parallel Ruler; and find its Area both by equidistant Ordinates and Casting.

	A N	
0	1200	
M 190	1000	L
K 260	800	H
G 270	600	F
E 250	400	D
C 180	200	B
0	000	
From	A, go	E.



Having laid down the figure, erect the perpendiculars A P, for a temporary line.

Lay the ruler from A to E; move it parallel to C; and mark the temporary line at 1.

Lay the ruler from 1 to G; move it parallel to E; and mark the temporary line at 2.

Lay the ruler from 2 to K; move it parallel to G; and mark the temporary line at 3.

Lay the ruler from 3 to M; move it parallel to K; and mark the temporary line at 4.

Lay the ruler from 4 to N; move it parallel to M; and mark the temporary line at 5.

Draw a line from N to 5 (P); and N A P, will be the right-angled triangle required.

Computation of the Area by equidistant Ordinates. See Prob. 9, Part III.

Here the sum of the first and last ordinates is nothing; (180 + 270 + 190) × 4 = 640 × 4 = 2560, four times the sum of the even ordinates; and (250 + 260) × 2 = 510 × 2 = 1020, twice the sum of the odd ordinates; then $\frac{2560 + 1020 \times 200}{3}$ $= \frac{3580 \times 200}{3} = \frac{716000}{3} = 238666$ square links = 2A. 1R. 21.8P. the area required.

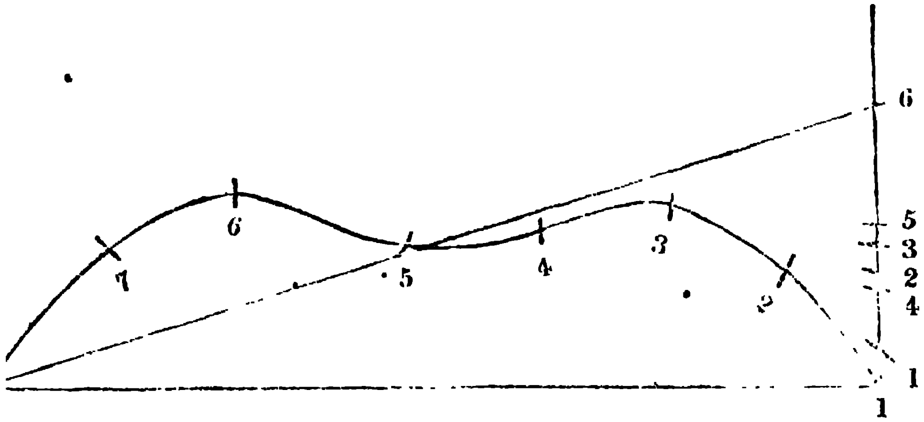
Computation of the Area by Casting.

Measure the perpendicular A P, which you will find to be 398 links; then $\frac{398 \times 1200}{2} = \frac{477600}{2} = 238800$ square links = 2A. 1R. 22P. the area required; which differs only two-tenths of a perch from that found by equidistant ordinates.

Note.—When a curve-line offset is to be reduced to a triangle by the parallel ruler, a competent number of points must be assumed in the curve, to denote angles. These points must be taken at such distances from each other, that a right line drawn between any two adjacent points, would *nearly* coincide with the curve.

PROBLEM VI.

It is required to reduce the following curve-line Offset to a right-angled Triangle by the Parallel Ruler.



Erect a perpendicular at one end of the base for a temporary line; and assume a competent number of points in the curve, to denote angles.

Lay the ruler from 1 to 3; move it parallel to 2; and mark the temporary line at 1.

Lay the ruler from 1 to 4; move it parallel to 3; and mark the temporary line at 2.

Lay the ruler from 2 to 5; move it parallel to 4; and mark the temporary line at 3.

Lay the ruler from 3 to 6; move it parallel to 5; and mark the temporary line at 4.

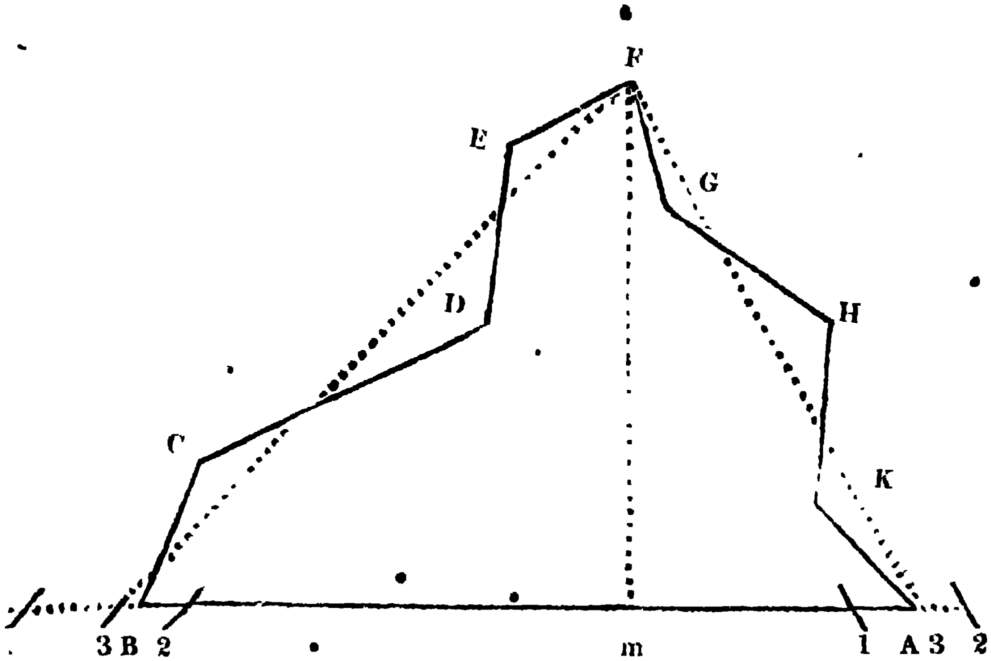
Lay the ruler from 4 to 7; move it parallel to 6; and mark the temporary line at 5.

Lay the ruler from 5 to 8; move it parallel to 7; and mark the temporary line at 6.

Draw a line from 8 to 6; and 8, 1, 6, is the triangle required; hence the area of the irregular offset may be found by multiplying the base 1, 8, by half the perpendicular 1, 6.

PROBLEM VII.

It is required to reduce the irregular Figure A B C D E F G H K, to a Triangle, by the Parallel Ruler.



Produce the base A B, both ways, at pleasure, for a temporary line.

Lay the ruler from A to H; move it parallel to K; and mark the temporary line at 1..

Lay the ruler from 1 to G; move it parallel to H; and mark the temporary line at 2.

Lay the ruler from 2 to F; move it parallel to G; and mark the temporary line at 3.

Draw a line from F to 3; and it will be a side of the required triangle.

Again, lay the ruler from B to D; move it parallel to C; and mark the temporary line at 1.

Lay the ruler from 1 to E; move it parallel to D; and mark the temporary line at 2.

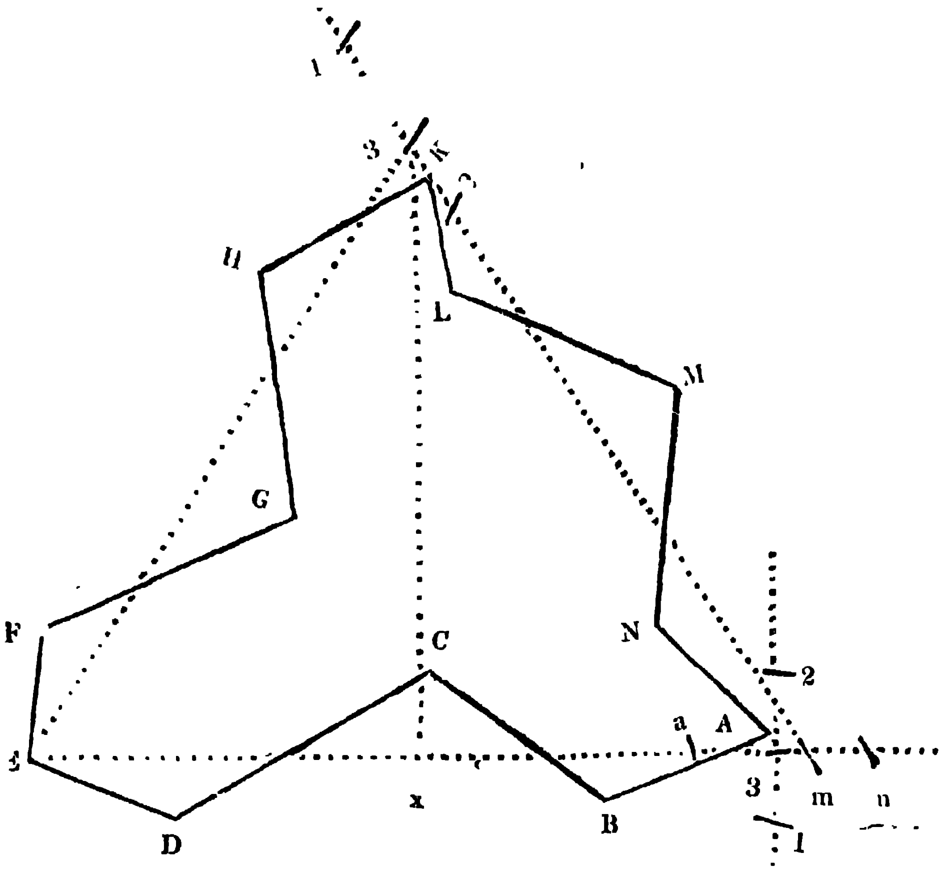
Lay the ruler from 2 to F; move it parallel to E; and mark the temporary line at 3.

Draw a line from F to 3; and 3 F 3 will be the triangle required; hence the area of the irregular figure A B C D E F G H K, may be found by multiplying the base 3, 3, by half the perpendicular F m.

Note.—The method of reducing fields of four or five sides, to triangles of equal areas, may be seen in Problems 16 and 17, Part I.

PROBLEM VIII.

It is required to reduce the irregular Figure A B C D E F G H K L M N, to a Triangle, by the Parallel Ruler.



Draw the temporary line 1, 2, to touch the angle A.

Lay the ruler from A to C; move it parallel to B; and mark the temporary line at 1.

Lay the ruler from 1 to D; move it parallel to C; and mark the temporary line at 2.

Lay the ruler from 2 to E; move it parallel to D; and mark the temporary line at 3.

Draw a line from E to 3; and produce it at pleasure, for a temporary line.

Lay the ruler from 3 to M; move it parallel to N; and mark the temporary line at a.

Lay the ruler from a to L; move it parallel to M; and mark the temporary line at n.

Lay the ruler from n to K; move it parallel to L; and mark the temporary line at m.

Draw a line from m to K; and produce it at pleasure, for a temporary line.

Lay the ruler from K to G; move it parallel to H; and mark the temporary line at 1.

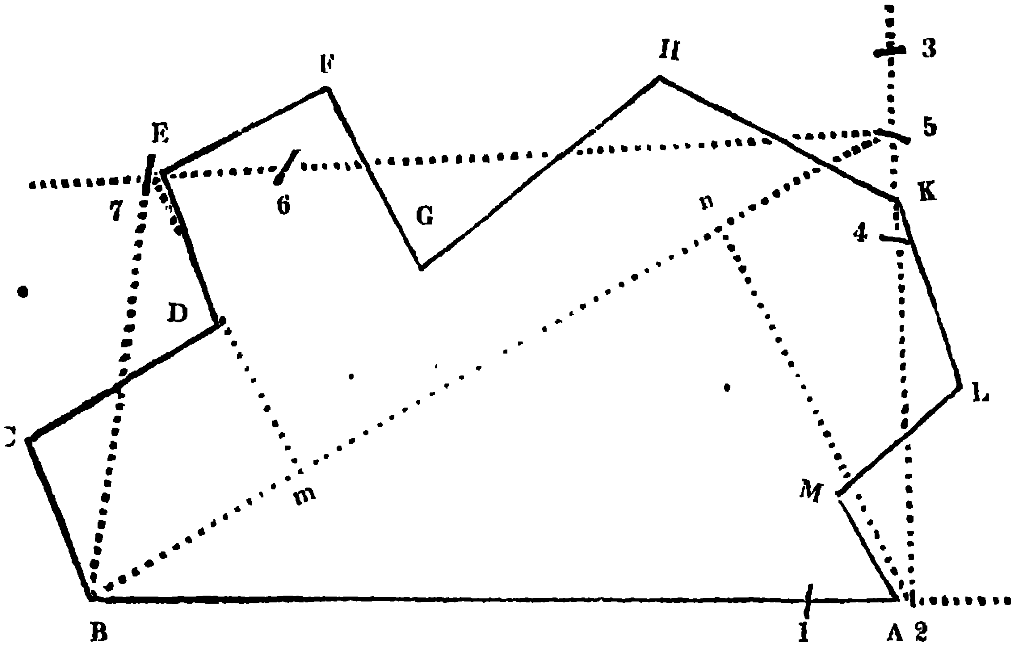
Lay the ruler from 1 to F; move it parallel to G; and mark the temporary line at 2.

Lay the ruler from 2 to E; move it parallel to F; and mark the temporary line at 3.

Draw a line from E to 3; and E 3 m, will be the triangle required; hence the area of the irregular figure A B C D E F G H K L M N, may be found by multiplying the base E m by half the perpendicular 3 x.

PROBLEM IX.

It is required to reduce the irregular Figure A B C D E F G H K L M, to a Trapezium, by the Parallel Ruler.



Produce the line A B, at pleasure, for a temporary line.

Lay the ruler from A to L; move it parallel to M; and mark the temporary line at 1.

Lay the ruler from 1 to K; move it parallel to L; and mark the temporary line at 2.

Draw a line from 2 to K; and produce it at pleasure, for a temporary line.

Lay the ruler from K to G; move it parallel to H; and mark the temporary line at 3.

Lay the ruler from 3 to F; move it parallel to G; and mark the temporary line at 4.

Lay the ruler from 4 to E; move it parallel to F; and mark the temporary line at 5.

Draw a line from 5 to E; and produce it at pleasure, for a temporary line.

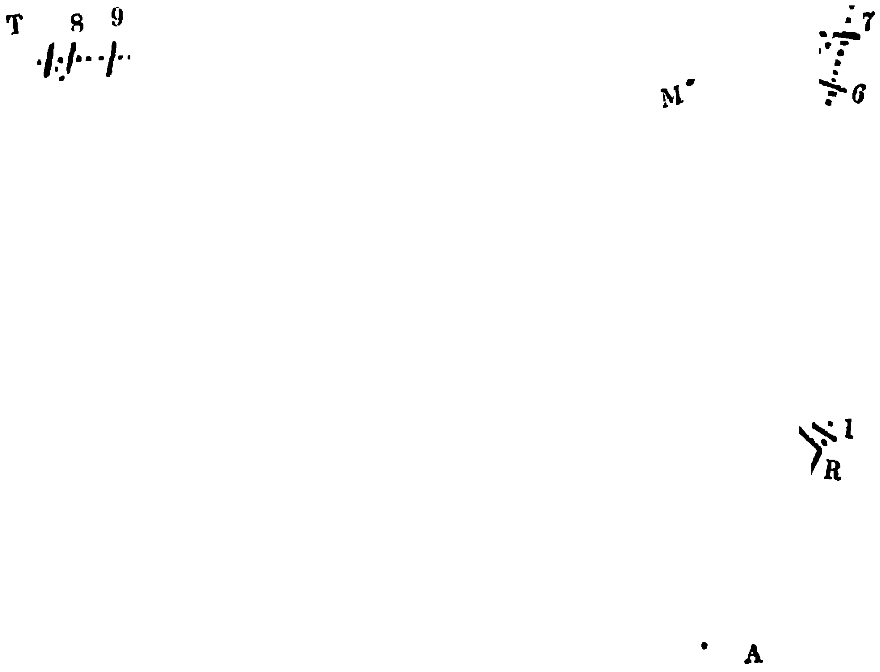
Lay the ruler from E to C; move it parallel to D; and mark the temporary line at 6.

Lay the ruler from 6 to B; move it parallel to C; and mark the temporary line at 7.

Draw a line from 7 to B; and B, 7, 5, 2, will be the trapezium required; hence the area of the irregular figure A B C D E F G H K L M, may be found by multiplying the diagonal B 5, by half the sum of the two perpendiculars 7 m and 2 n.

PROBLEM X.

It is required to reduce the irregular Figure A B C D E F G H K L M N P R, to a Trapezium, by the Paraller Ruler.



Continue A R, for a temporary line.

Lay the ruler from A to C; move it parallel to B; and mark the temporary line at 1.

Lay the ruler from 1 to D; move it parallel to C; and mark the temporary line at 2.

Draw a line from D to 2; and produce it at pleasure, for a temporary line.

Lay the ruler from 2 to P; move it parallel to R; and mark the temporary line at 3.

Lay the ruler from 3 to N; move it parallel to P; and mark the temporary line at 4.

Draw a line from 4 to N; and produce it at pleasure, for a temporary line.

Lay the ruler from N to L; move it parallel to M; and mark the temporary line at 5.

Lay the ruler from 5 to K; move it parallel to L; and mark the temporary line at 6.

Lay the ruler from 6 to H; move it parallel to K; and mark the temporary line at 7.

Draw a line from 7 to H; and produce it at pleasure, for a temporary line.

Lay the ruler from H to F; move it parallel to G; and mark the temporary line at 8.

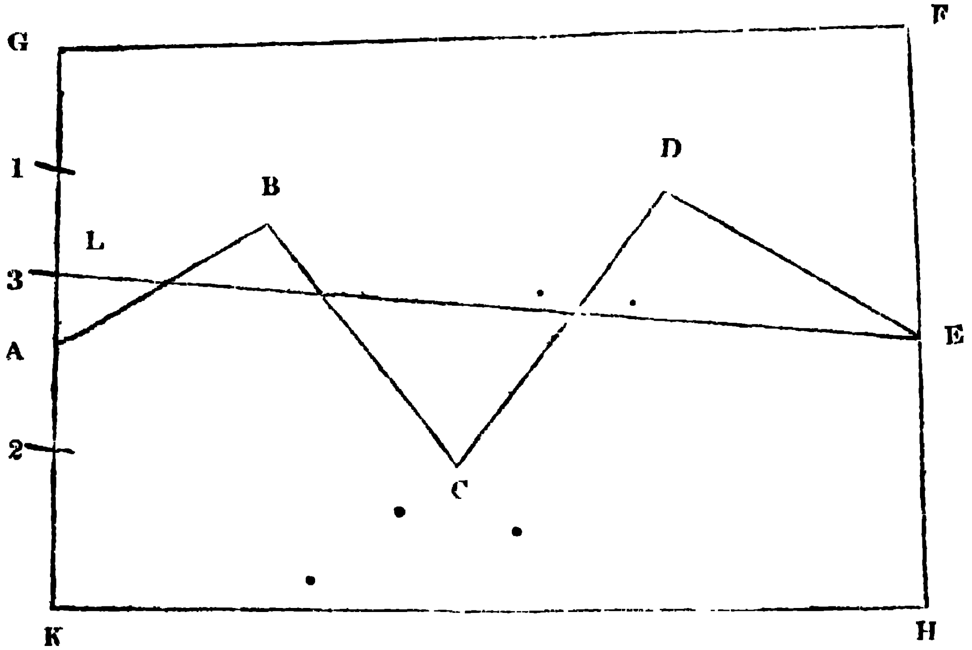
Lay the ruler from 8 to E; move it parallel to F; and mark the temporary line at 9.

Lay the ruler from 9 to D; move it parallel to E; and mark the temporary line at T.

Draw the line D T; and D T 7, 4, will be the trapezium required; hence the area of the irregular figure may be found by multiplying the diagonal D 7, by half the sum of the two perpendiculars T m and 4 n.

PROBLEM XI.

It is required to draw an equalising Line, by the Parallel Ruler, through the irregular Fences A B C D E, so that the two Fields which they separate, may be reduced to Trapeziums.



Lay the ruler from A to C; move it parallel to B; and mark the temporary line K G, at 1.

Lay the ruler from 1 to D; move it parallel to C; and mark the temporary line at 2.

Lay the ruler from 2 to E; move it parallel to D; and mark the temporary line at 3.

Draw a line from E to 3 (L); and the irregular figure A B C D E F G, will be reduced to the trapezium L E F G; and the irregular figure A B C D E H K, to the trapezium L E H K; hence their respective areas may be obtained by measuring diagonals and perpendiculars.

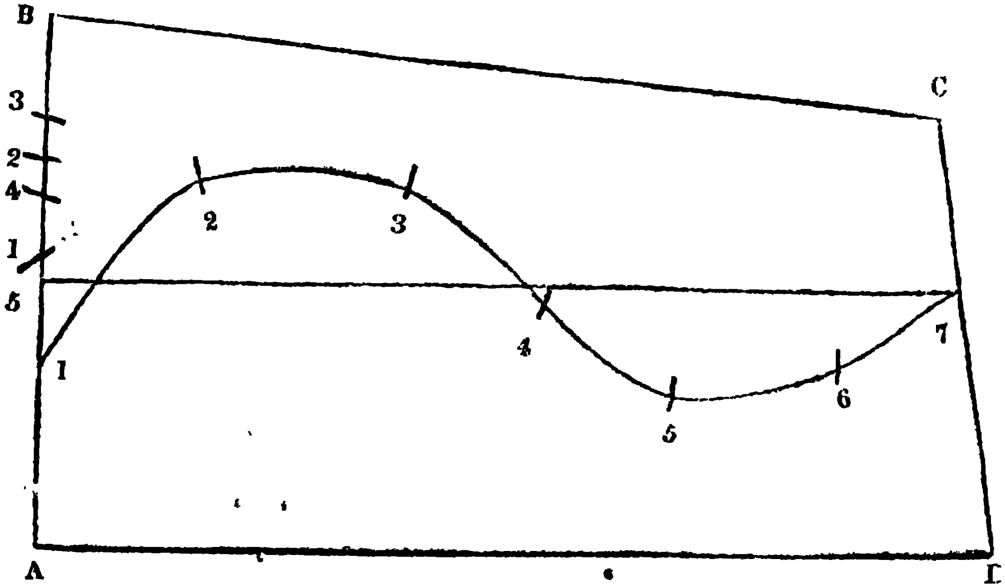
Note 1.—Sometimes the proprietors of adjoining estates agree to straighten crooked fences or brooks, by *giving* and *taking* equal quantities of land.

When this is the case, you must first measure and plan the ground; then draw the equalising line as directed in the last Problem; and take the distance from A to L, very correctly by the scale. Measure this distance in the field, from the angle A; range the division line E L, and stake it out; and the work will be completed.

2.—It will be advisable to measure, both on the plan and in the field, the parts cut off on each side, by the division line, in order to prove the work; for an error committed in dividing land, is of serious consequence, if it be not discovered and rectified before the new fence is made. If the discovery takes place after the ground has been fenced off, either the fence must be altered, or the land must be valued; and the person who has had too much awarded to him, must pay the balance.

PROBLEM XII.

It is required to draw an equalising Line by the Parallel Ruler, so that the curved Fence which separates the two Fields in the following Figure, may be reduced to a straight Fence.



Lay the ruler from 1 to 3; move it parallel to 2; and mark the temporary line A B, at 1.

Lay the ruler from 1 to 4; move it parallel to 3; and mark the temporary line at 2.

Lay the ruler from 2 to 5; move it parallel to 4; and mark the temporary line at 3.

Lay the ruler from 3 to 6; move it parallel to 5; and mark the temporary line at 4.

Lay the ruler from 4 to 7; move it parallel to 6; and mark the temporary line at 5.

Draw a line from 7 to 5, and it will reduce the figure A B C D, to two trapeziums; hence their respective areas may be found by measuring diagonals and perpendiculars.

The following general Rule for the Parallel Ruler, will be found of considerable service to learners; and may be easily committed to memory.

GENERAL RULE.

1. LAY the ruler from the first to the third angle; move it parallel to the second angle; and you will have the first mark on the temporary line.
2. Lay the ruler from the first mark on the temporary line, to the fourth angle; move it parallel to the third angle; and you will have the second mark on the temporary line.
3. Lay the ruler from the second mark on the temporary line, to the fifth angle; move it parallel to the fourth angle; and you will have the third mark on the temporary line.
4. Lay the ruler from the third mark on the temporary line, to the sixth angle; move it parallel to the fifth angle; and you will have the fourth mark on the temporary line.
5. Lay the ruler from the fourth mark on the temporary line, to the seventh angle; move it parallel to the sixth angle; and you will have the fifth mark on the temporary line.
6. Lay the ruler from the fifth mark on the temporary line, to the eighth angle; move it parallel to the seventh angle; and you will have the sixth mark on the temporary line.

7. Lay the ruler from the sixth mark on the temporary line, to the ninth angle; move it parallel to the eighth angle; and you will have the seventh mark on the temporary line.

8. Lay the ruler from the seventh mark on the temporary line, to the tenth angle; move it parallel to the ninth angle; and you will have the eighth mark on the temporary line, &c. &c.

Note.—As the operations of the parallel ruler, in straightening crooked fences, are founded upon a mathematical truth, it is certainly, in most cases, preferable to a lantern horn; but in large surveys, where the fences are much curved, it will be found that the latter may be applied with much more expedition than the former; and if it be used by a *skilful* hand, its results will be sufficiently correct for *general* practice. (See Problems I. and II. Part IV.)

A BOOK OF DIMENSIONS, CASTINGS, AND AREAS,

Names of the Proprietors.	No. on the Plan.	Diagonals.	First Perpen.	Second Perpen.	Sum of Perpen.	Quantity in A. Dec.	Quantity in A.	R.	P.
Mr. Dalton's Close	1	625	180	-	180	1.12500	1	0	20
Mr. Cayley's Close	2	916	52	247	299	2.73884	2	2	38
Mr. Whisker's Close	3	742	123	155	278	2.06276	2	0	10
Mr. Straker's Close	4	2094	160	481	641	13.42254	13	1	28
Mr. Straker's Close	5	1855	328	268	596	11.05580	11	0	9
Mr. Ellard's Close	6	2197	574	-	574	12.61078	12	2	18
Whole Quantity						43.01572	43	0	3

Note 1.—In the first edition of this Work, the content of the estate, in Plate VIII. was found from a plan of 2 chains to an inch. The bases, diagonals, and perpendiculars, were measured by the scale used in planning; the offsets taken in the field were used, where convenient; and when those were insufficient, more were measured by the scale. In this edition, the crooked fences have been straightened by the Parallel Ruler; the bases and diagonals measured by a scale of 2 chains to an inch; and the perpendiculars by a scale of 1 chain to an inch; hence the area of each triangle was found by multiplying the base by the perpendicular, and the area of each trapezium by multiplying the diagonal by the sum of the two perpendiculars.

The diagonals, perpendiculars, and areas are entered in the foregoing book of castings; and it may also be observed that the bases of triangles are put down in the column of diagonals, and their perpendiculars, in the first column of perpendiculars. (See Notes 1 and 2, Method of computing the Contents, Part V.)

2.—In straightening crooked fences by the Parallel Ruler, it frequently happens that one equalising line will serve for two adjoining fields; and almost every irregular figure may be reduced either to a triangle, or a trapezium. (See Problems 16 and 17, Part I.; and also the Use of the Parallel Ruler, Part V.)

A BOOK OF DIMENSIONS, CASTINGS, AND AREAS,

Belonging to Plate X.

Names of the Fields.	No. on the Plan.	Diagonals.	First Perpen.	Second Perpen.	Sum of Perpen.	Quantity in A. Dec.	Quantity in A.	R.	P.
Grime Garth	1	1166	265	95	360	4.19760	4	0	32
House Ing	2	1581	440	——	440	6.95640	6	3	33
Sandy Field	3	1098	196	97	293	3.21714	3	0	35
Low Holme	4	861	259	88	347	2.98767	2	3	38
Brook Close	5	1130	215	——	215	2.42950	2	1	29
Low Close	6	969	243	——	243	2.35467	2	1	17
Marsh Close	7	1209	336	——	336	4.06224	4	0	10
Green Meadow ...	8	846	153	200	353	2.98638	2	3	38
Horse Pasture ...	9	741	161	170	331	2.45271	2	1	32
Cow Pasture	10	962	150	104	254	2.44348	2	1	31
Calf Garth	11	725	180	133	313	2.26925	2	1	3
Long Meadow ...	12	1781	226	224	450	8.01450	8	0	2
River Close	13	810	178	174	352	2.85120	2	3	16
Primrose Close ...	14	1046	183	210	393	4.11078	4	0	18
Bridge Ing	15	1733	287	153	440	7.62520	7	2	20
Shady Ing	16	875	159	187	346	3.02750	3	0	4
Hare Park	17	880	147	167	314	2.76320	2	3	2
Long Tongue	18	1092	284	——	284	3.10128	3	0	16
Whole Quantity						67.85670	67	3	16

Note.—In the first edition of this Work, the content of the estate, in Plate X. was found from a plan of 2 chains to an inch, by making the crooked fences straight by a lantern horn, as directed in Part IV. In this edition all the crooked fences have been straightened by the Parallel Ruler; the bases and diagonals measured by a scale of 2 chains to an inch, and the perpendiculars by a scale of 1 chain to an inch; and hence the foregoing Book of Dimensions, Castings, and Areas, was formed.

TO TRANSFER A ROUGH PLAN TO A CLEAN SHEET OF PAPER, OR TO A SKIN OF PARCHMENT OR VELLUM, IN ORDER TO MAKE A FINISHED PLAN; ALSO TO ENLARGE OR REDUCE PLANS, &c.

METHOD I.

By Points.

Having laid the fresh sheet upon a smooth table, lay the rough plan upon it; and with four small nails, (or weights, or books,) fasten the corners of both to the table. Then, with your pricker, pierce the extremities of straight lines, and as much of the curved ones as will enable you to draw them on the new plan. Next separate the papers, and trace the outlines and fences with a black lead pencil, after which draw them with a fine pen and good Indian ink.

Note.—Common ink ought never to be used in planning, because it not only sinks too deep into the paper, but generally, in process of time, becomes discoloured.

METHOD II.

By Tracing Paper.

Take a sheet of writing paper, of the same size as the rough plan, and rub one side of it with black lead powder; then lay it upon the sheet which you intend for your new plan, with the black side downward; upon both lay the rough plan, and fasten them all to the table, as before directed. Next, run your tracer gently over all the lines upon the plan, so that the black lead under them, may be transferred to the fresh paper. They must then be drawn with Indian ink, as before directed.

Note.—This method of transferring is preferrable to the former, because it does not injure the plans.

METHOD III.

By a Copying Glass.

A copying glass is a large square, or rectangular piece of the best window glass, fixed in a frame of wood, which can be raised to any angle, like a desk, the lower side resting upon a table; and a screen of blue paper may be fitted to the upper edge, and stand at right angles to it.

Place this frame at a convenient angle, against a strong light; fix the old plan and clean paper firmly together by pins, the clean paper uppermost, and on the face of the plan to be copied; lay them with the back of the old plan next the glass, namely, that part which you intend to copy first.

The light through the glass will enable you to perceive distinctly every line of the plan upon the clean paper, and you can easily trace over them with a pencil; and having finished that part which covers the glass, slide another part over it, and copy this, and thus continue till the whole be copied.

Note.—Those who have not a copying glass, may use a rectangular piece of window glass fixed in a common frame; and when copying, it may be placed in an inclining position, with its top against a window, and its bottom upon the window-seat, if it be nearly level with the bottom of the window. A pane in a window is not unfrequently used for copying small drawings.

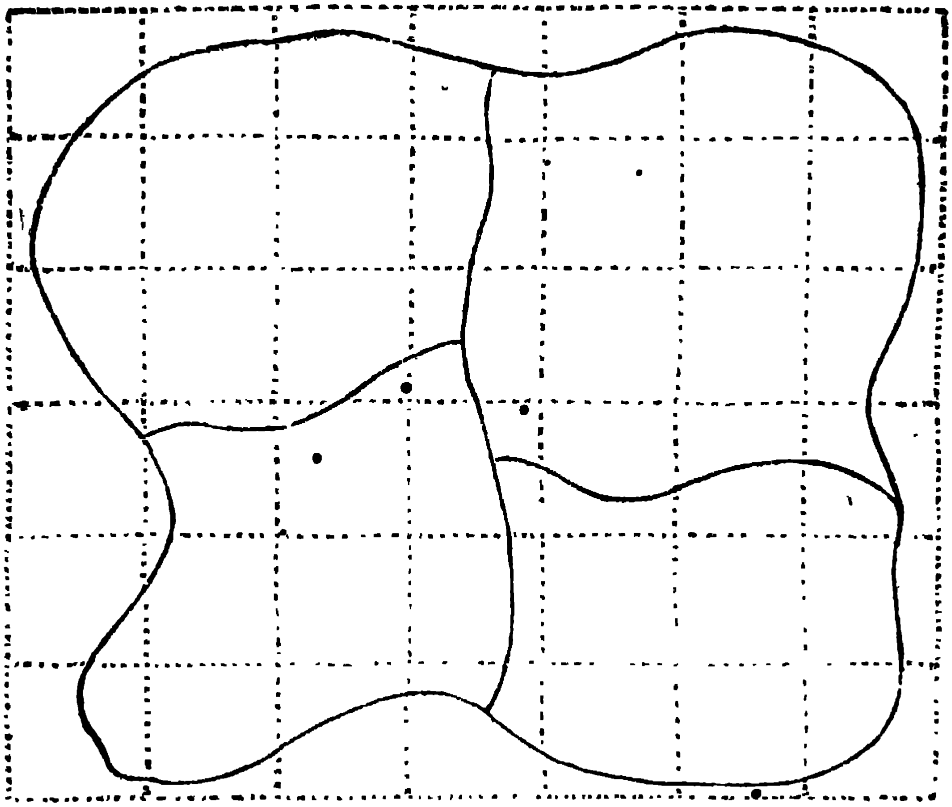
METHOD IV.

By similar Squares.

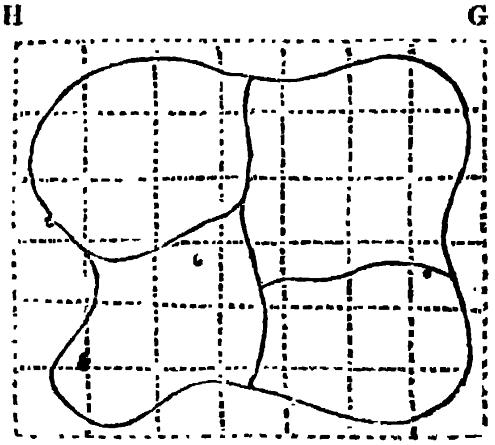
The three foregoing methods of transferring or copying plans, can only be applied, when the rough plan is of the same size which you wish the finished one to be; but as it may be necessary to reduce the size of the original, this may be done by similar squares.

EXAMPLE.

Suppose the following inclosures to have been laid down by a scale of 2 chains to an inch; it is required to reduce them to one of 4 chains to an inch.



By a scale of 2 chains to an inch, draw the line A B = 7 chains. At A and B erect the perpendiculars A D and B C, each of which make = 6 chains; and join D C. Divide the lines A B and D C, each into 7 equal parts; and the lines A D and B C, each into 6 equal parts; join the opposite points of division, and the rectangle A B C D, will be divided into 42 equal squares, the side of each being one chain.



Next, by a scale of 4 chains to an inch, draw the line E F = 7 chains. At E and F erect the perpendiculars E H and F G, each of which make = 6 chains; and join H G. Divide the lines E F and H G, each into 7 equal parts; and the lines E H and F G each into 6 equal parts; join the opposite points of division, and the rectangle E F G H will be divided into 42 equal squares, the sides of which will be exactly half the size of those in the rectangle A B C D.

Then, with your pencil, draw within the rectangle E F G H the fences contained within the rectangle A B C D; making each fence pass through its proper situation in the corresponding squares, which may be done by observing where the lines forming the squares, intersect the fences. Afterward trace the fences with Indian ink, as before directed.

Note.—In copying or reducing a large plan, by this method, you ought to number the corresponding squares, in the circumscribing rectangles, with the same figures, in order to prevent mistakes. These figures, as well as the lines forming the squares, should be made with a pencil, and effaced after the plan is copied.

METHOD V.

By the Pentagraph.

No instrument that has hitherto been invented is equal to the pentagraph, for reducing, copying, or enlarging plans. It is not only the most expeditious, but also the most correct; as it copies every straight and curved line with the greatest exactness. It is as useful to an experienced draftsman, as to those who have had but little practice in drawing. It saves much time either in copying, reducing, or enlarging plans; and may be used with equal facility for copying figures, profiles, sea-charts, maps, landscapes, &c. &c.

Pentagraphs may be had of most of the Mathematical Instrument Makers; and in Mr. Jones's Catalogue, the price is from 1*l.* 18*s.* to 6*l.* 16*s.* 6*d.*

DESCRIPTION OF THE PENTAGRAPH.

See Plate V.

The pentagraph is generally made of wood, or brass, from 12 inches to two feet in length, and consists of four flat bars or rulers; two of them long, and two short. The two longer are joined at the end A, by a double pivot, which is fixed to one of the rulers; and works in two small holes placed at the end of the other. Under the joint is an ivory castor, to support this end of the instrument. The two smaller rulers are fixed by pivots at E and H, near the middle of the larger rulers; and are also joined together at their other end, G.

By the construction of this instrument, the four rulers always form a parallelogram. There is a sliding box on the longer arm, and another on the shorter arm. These boxes may be fixed at any part of the rulers, by means of their milled screws; and each of these boxes are furnished with a cylindric tube, to carry either the tracing point, pencil, or fulcrum.

The fulcrum, or support K, is a leaden weight; on this the whole instrument moves when in use.

To the longer instruments are sometimes placed two moveable rollers, to support the pentagraph, and facilitate its motions. Their situation may be varied as occasion requires.

The graduations are placed on two of the rulers, B and D, with the proportions of $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c. to $\frac{1}{12}$, marked on them.

The pencil-holder, tracer, and fulcrum, must in all cases be in a right line, so that when they are set to any number, if a string be stretched over them, and they do not coincide with it, there is an error either in the setting or gradations.

The long tube which carries the pencil, or crayon, moves easily up or down in another tube; there is a string affixed to the long, or inner tube, passing afterwards through the holes in the three small knobs to the tracing point, where it may, if necessary, be fastened. By pulling this string, the pencil is lifted up occasionally, and thus prevented from making false or improper marks upon the copy.

THE USE OF THE PENTAGRAPH.

To reduce a Plan in any of the Proportions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, *&c. as marked on the two Bars B and D. Suppose, for example,* $\frac{1}{2}$ *is required.*

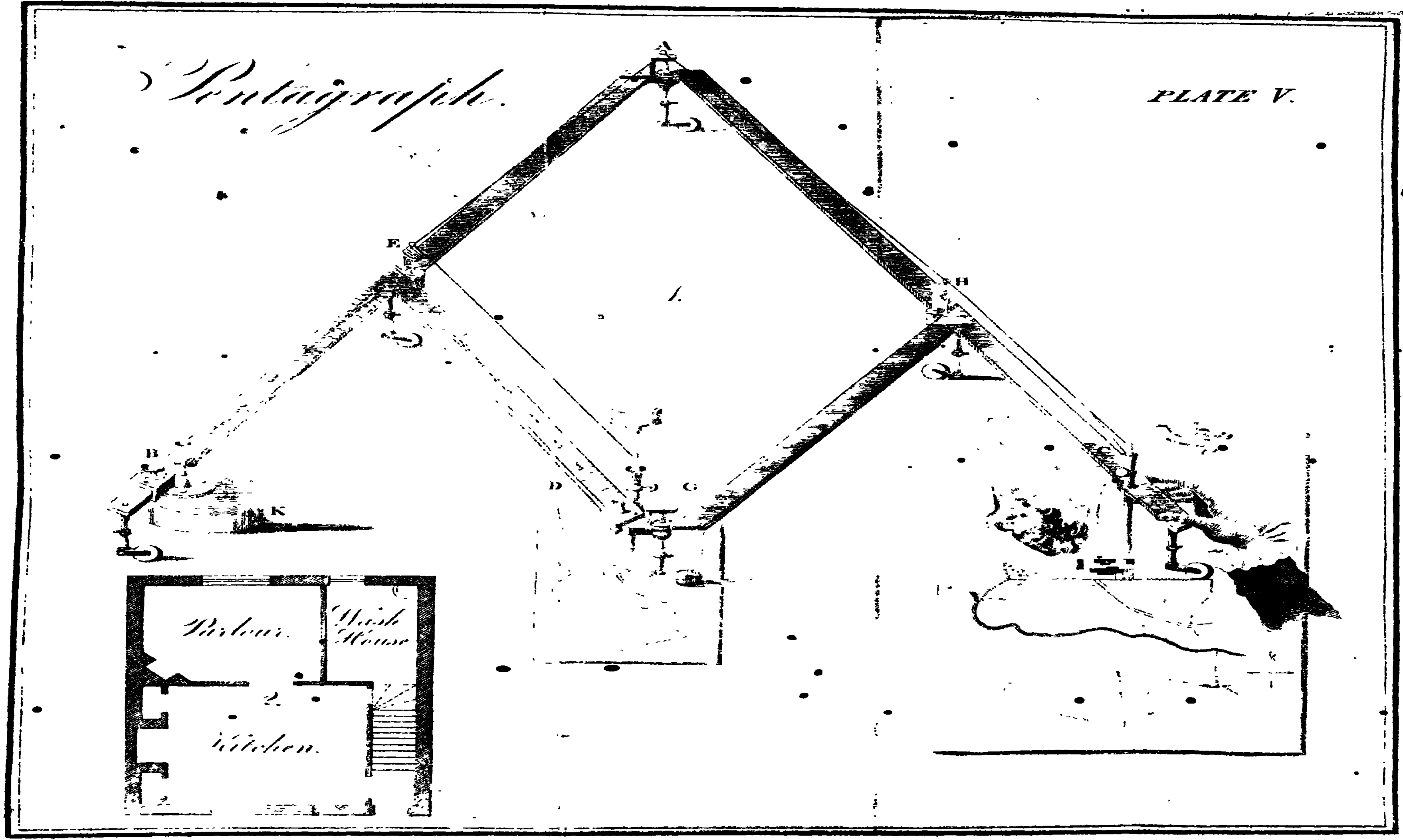
Place the two sockets, at $\frac{1}{2}$, on the bars B and D, the fulcrum, or lead weight at B, the pencil socket with the pencil, at D, and the tracing point at C. Fasten down upon a smooth board, or table, a sheet of white paper under the pencil D, and the original map, &c. under the tracing point C, allowing yourself room enough for the various openings of the instrument. Then with a steady hand carefully move the tracing point C, over all the lines on the map; and the pencil at D will describe exactly the same figure as the original, but $\frac{1}{2}$ the size. In the same manner for any other proportion, by setting the two sockets to the number of the required proportion.

The pencil-holder moves easily in the socket, to give way to any irregularity in the paper. There is a cup at the top for receiving an additional weight, either to keep down the pencil to the paper, or to increase the strength of its mark.

A silken string is fastened to the pencil-holder, in order that the pencil may be drawn up off the paper, to prevent false marks when crossing the original plan, in the operation.

PLATE V.

Pentagraph.



If the original should be so large, that the instrument will not extend over it at one operation, two or three points must be marked on the original, to correspond with the same upon the copy. The fulcrum and copy may then be removed into such situations as to admit the copying of the remaining part of the original; first observing, that when the tracing point is applied to the three points marked on the original, the pencil falls on the three corresponding points upon the copy. In this manner, by repeated shiftings, a pentagraph may be made to copy an original of ever so large dimensions.

To enlarge a Plan in any of the proportions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c. Suppose $\frac{1}{2}$.

Set the two sockets at $\frac{1}{2}$, as before, and change places of the pencil and tracing point; namely, place the tracing point at D, and the pencil at C.

To copy a Plan the same size as the Original.

Place the two sockets at $\frac{1}{2}$, the fulcrum at D, and the pencil at B. In this case, the lines upon the new plan will be reversed, in copying.

Note 1.—There are sometimes divisions of 100 unequal parts laid down on the bars B and D, to give any intermediate proportion, not shewn by the fractional numbers.

2.—Pentagraphs of a greater length than two feet are best made of hard wood, mounted in brass, with steel centres, upon the truth of which depends entirely the equable action of this useful instrument.

3.—Though I have given various methods of reducing plans, I would advise the learner, after he has found the contents from a plan of 2 chains, or of 1 chain to an inch, to draw another rough plan, of the same size which he intends his finished one to be; and then to transfer it to a clean sheet by any of the foregoing methods. This may appear a little tedious, but it will make the learner very expert in laying down his lines, which will be found of great advantage to him, when he enters upon the practical part of surveying.

TO EMBELLISH A PLAN.

In order to make a neat, finished plan, some knowledge of drawing is absolutely necessary. The learner should also be a proficient in plain and ornamental penmanship; or he will not be able to finish a plan, either with beauty or elegance. Every person who would excel in this art, should devote all his leisure hours to copying and making out drawings, either from plans or copperplates well executed; as nothing but practice will make a good draftsman.

METHOD I.

Plans neatly finished with Indian Ink and Colours.

Having transferred the plan to a clean sheet of drawing-paper, or to a skin of parchment or vellum, by any of the foregoing methods, draw all the straight lines very finely, by the edge of a ruler, with a drawing-pen and Indian ink; but the curved lines must be drawn by a steady hand.

Proceed next to make the representation of hedges, bushes, trees, woods, gates, stiles, bridges, the bases of buildings, &c. &c. in their proper places; running a single dotted line, in an open field, for a foot-path, and a double one for a carriage-road.

Hills may be shaded with a brush or hair-pencil, and Indian ink. The first wash should be weak, and the edges of the shade, particularly at the top and bottom of a hill, must be softened off with clear water, and a clean brush, kept for that purpose, at one end of the pencil-handle; the other end being occupied by the Indian ink brush.

When the hills are very steep, and rise one above another, as those in Wales, Derbyshire, Yorkshire, Westmoreland, Cumberland, Northumberland, and Scotland, they must all be shaded according to their various inclinations; always letting one wash dry before another is laid on; and never neglecting to soften off the edges of each shade with water.

If some parts of the hills be rocky, tint them with a colour resembling stone, after they have been shaded with Indian ink and a hair-pencil, in the manner exhibited in No. 2, Plate VII.

It may also be observed that when the inclination of a hill is considerable, it is never noticed by Surveyors, in shading or finishing their plans; and if hills be flat at the top, they are left nearly white.

The method of shading high moorish ground, and hilly fields, may be seen in Plates VI. and VII.; except they must not be done with lines, in imitation of engraving, but with repeated washes of Indian ink.

After hills have been properly shaded with Indian ink, they may then be coloured in the manner hereafter directed for meadow, pasture, and arable land.

Lakes, rivers, brooks, &c. may also be shaded with a brush and Indian ink, pretty strongly at the edges, and softened off towards the middle; and when they are dry, they may be washed over with a light tint of Prussian blue. The shape of arrows should also be made in brooks and rivers, to shew in what direction the streams run.

Meadow and pasture ground should be coloured with a transparent green, the pasture rather lighter than the meadow; arable land with various shades of fine brown, so that too many fields may not appear exactly alike; and some Surveyors use both red, blue, lake, and yellow, in colouring plans.

If the quick-wood hedges be not made with a pen and Indian ink, in imitation of bushes, they may be represented by running narrow shades of colouring along the black lines which form the boundaries of the different inclosures.

Roads should be washed with a brownish tint, and the bases of buildings with a red one, or with Indian ink, laid on with a brush of a convenient size; as it is difficult to manage large brushes in shading small spaces.

Sands upon the sea-shore, may be washed over with a mixture of brown, lake, and gamboge.

Greens of various shades may be composed of blue and yellow; a pleasing variety of brownish tints may be produced by mixing lake, red, or yellow, with a little brown; and a shade for water may be formed of Indian ink and Prussian blue.

All the washes should be made thin, and laid on in a very neat manner; as nothing disfigures a plan or a map so much as daubing on the colours too thickly.

If the estate be small, the area of each inclosure may be put down in some vacant part of the plan; but if it be large, the areas must either be entered within the fields themselves, or in a book of particulars, which may also contain any remarks that the Surveyor may think necessary to make to his employer, concerning the estate.

In some convenient part of the plan, write, in various hands, with Indian ink, the title of the estate, ornamented with a compartment or device. In another vacancy, introduce the scale by which the plan has been laid down; and also a meridian-line, with the compass or flower-de-luce pointing to the north.

The whole may then be bordered with black lines at a convenient distance from each other; and the space between them shaded with a hair-pencil and Indian ink. See Plates IX. and XI. (*Also, vide Notes* 3, 4, 5, *and* 6, *page* 378.)

Note 1.—If the learner examine a well-finished, coloured map of England, or any other country, he will fully comprehend what has been said on the subject of embellishing plans.

2.—Indian ink must always be used in planning; and as it is frequently of a very bad quality, it is advisable to try it before you purchase, by wetting one end of the cake, and rubbing it upon white paper. The blackest and freest is considered the best.

3.—The most convenient colours are those ready prepared in cakes, which must be used in the following manner: Dip one end of the cake in clear water, and rub a little of it upon a clean wedgewood or earthen plate; then mix it with water, by your hair-pencil, until you have brought it to any consistency you please. Indian ink must be prepared for use in the same way.

4.—Mr. James Newman's water-colours, No. 24, Soho-Square, London, are considered the best. The following will be found quite sufficient for Land-Surveyors; viz.

Vandyke Brown.
Raw Sienna.
Burnt Sienna.
Gamboge.
Yellow Ochre.
Indian Yellow.
Light Red.
Lake.
Vermillion.
Prussian Blue.
Prussian Green.
Sap Green.

By means of these colours, a great variety of tints may be formed; and a little practice will soon enable the learner to produce any shade that may be wanted for plans, or maps.

5.—When the price for measuring and planning is *very small*, Surveyors generally finish their plans neatly; but without either colours, compartments, or embellishments of any kind.

6.—Professional Surveyors always enter in their Field-Books, the day of the month and date of the year, when they begin to survey an estate; and in finishing their Plans, they date them accordingly, and also insert their own names, in order that gentlemen may know when, and by whom their estates were surveyed.

METHOD II.

Plans highly finished with Indian Ink and Colours.

The foregoing method of finishing plans, is very expeditious, and may suffice when the price allowed for surveying will not admit of much time being spent in making embellishments; but when a highly finished plan is wanted, the following method must be adopted.

Meadows.

With a pen, or a very fine pointed hair-pencil, and light Indian ink, make perpendicular and inclining strokes over the whole meadow, as represented in No. 1, Plate VI.; and then wash it with a fine, transparent green. The strokes must be of various lengths; but none of them should exceed the 10th part of an inch.

Pasture Grounds.

Pastures may be shaded with upright and sloping strokes, of various lengths, as represented in No. 2, Plate VI.; and then washed over with a green, somewhat inclining to yellow. None of the strokes should exceed the 20th part of an inch in length.

Corn Fields.

By the edge of a ruler, or by the hand, draw (in short dashes) fine parallel lines, at equal distances from each other, so as to give the fields the appearance of being divided into ridges and furrows, as represented in Nos. 3 and 4, Plate VI.; and then wash each field over with a different tint of brown, inclining to yellow.

Corn-fields neatly finished in this manner, give a plan a very fine appearance.

Moors.

With a pen, or a hair-pencil, draw the representation of a few scattered hillocks, if there be any on the moor.

Draw also here and there, small bushes, to represent heath, broom, whins, and such like brushwood as usually grow upon moors.

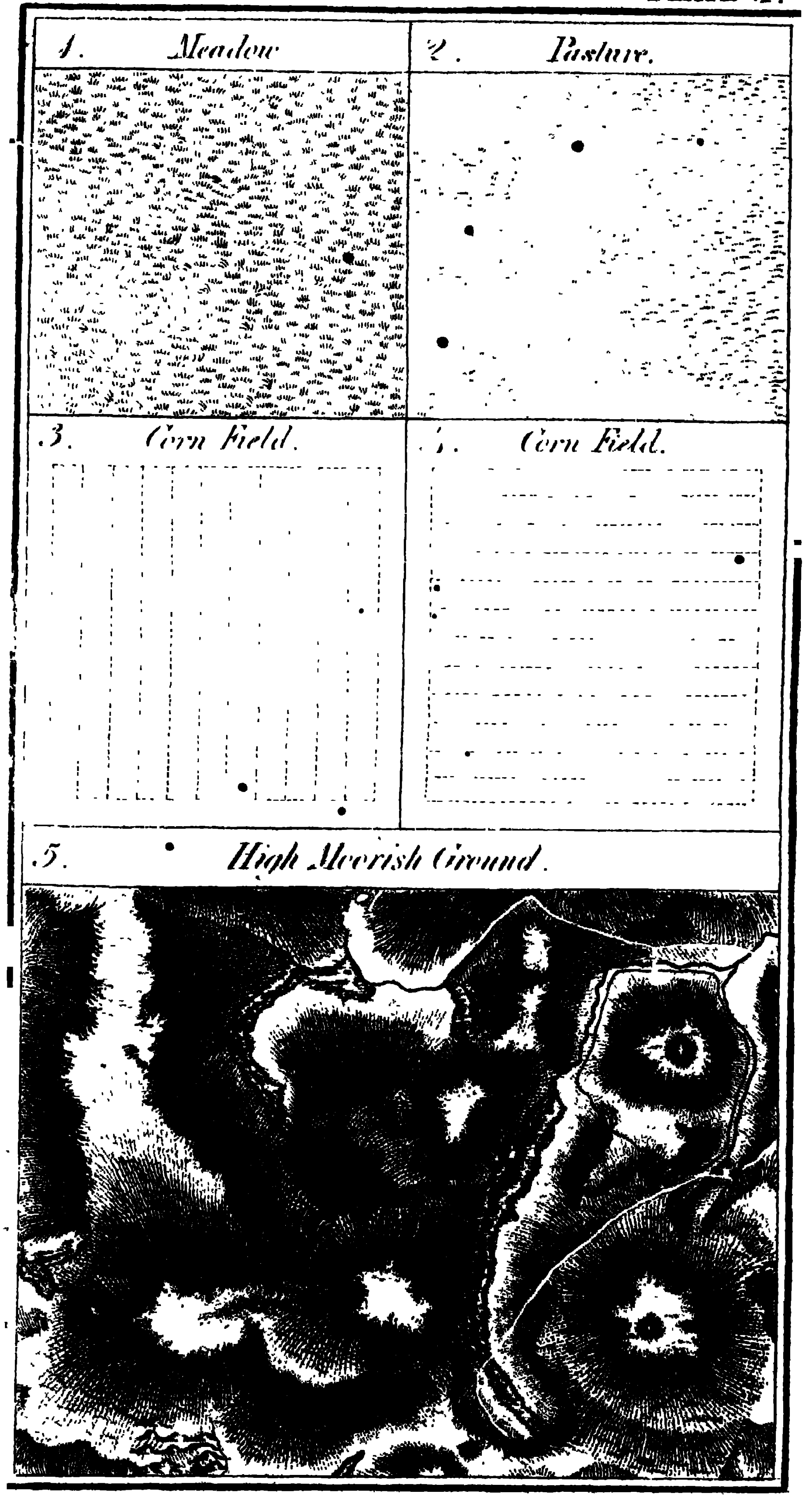
Make likewise tufts of grass, if the moor is pasturable; and then fill up all the vacant spaces with perpendicular and inclining strokes, as represented in Nos. 1 and 2, Plate VI.

If the moor be high, hilly, and rugged, with pools of water, caverns, roads, &c. it must be shaded with lines, in imitation of engraving, as exhibited in No. 5, Plate VI.; if any parts be wet and marshy, they must be done in the same manner as marshy ground; and if the moor contains large stones, rocks, or trees, they must not be omitted.

When you have finished shading with Indian ink, you must then colour the different parts of the moor, in the same manner as they appear in nature. The parts producing herbage, must be washed with a greenish colour, inclining to blue; the dark parts with a brownish tint; the lighter parts with a yellowish one, &c. &c.; and the shrubs and bushes may be touched up with a fine, lightish green.

If the moor contains whins, first wash them with green; and

PLATE VI.


1. Meadow
2. Pasture.
3. Corn Field.
4. Corn Field.
5. High Moorish Ground.

then touch them up on the west side with yellow, which will give them the appearance of being in blossom.

By proceeding as above directed, a variety of pleasing effects and shades will be produced: and you will be able to give your plan a very fine appearance, and make it resemble even nature itself.

Marshy Ground.

With a pen, or a fine pointed hair-pencil, and palish Indian ink, draw, by the hand, shortish horizontal strokes of various lengths, pretty closely to each other. Make also the representation of reeds, rushes, sedges, and strong herbage, as exhibited in No. 1, Plate VII.; wash the whole over with a palish green, inclining to blue; and then touch up the reeds, rushes, sedges, &c. with a stronger green, which soften off either towards the right or left, with a lighter one, or with clear water. (See the method of shading trees.)

Sands and Rocks.

Sands upon the sea-shore, &c. must be represented by small dots, with a pen and Indian ink; loose stones by figures resembling small circles and ovals, but more irregular; and rocks must be made to appear rugged and rough, and to rise in succession, one above another, as exhibited in No. 2, Plate VII. The sands may then be washed over with a mixture of brown, lake, and gamboge; and the stones and rocks coloured with such tints as will give them the appearance of nature. Some stones and rocks are whitish, some yellowish, some greyish, others brownish, &c.; hence the propriety of always taking their real colour into consideration, when we intend to give a faithful representation upon a plan.

Trees.

Trees always adorn and beautify the face of nature; and when they are neatly drawn, with a fine pen and Indian ink, they give a plan a very beautiful and pleasing appearance.

They must be made with vertical stems, neat, broadish tops, shaded darker on one side than the other; and black, horizontal shades at the bottom, as represented in No. 3, Plate VII.

The lighter parts of the trees represent that side upon which the light is supposed to fall; and the horizontal shades at the bottom are intended to denote the shadows of the trees, upon the ground. These shadows must always be made on the darker sides of trees; and also of every other object, where shadows are intended to be represented.

It is not material which side of a tree be left light; but we must take care to make all the trees in the same wood, light on the same side; for we cannot suppose that the light can fall on the right of some trees, and on the left of others, at the same time.

When a sufficient number of trees have been made to give the wood an agreeable appearance, the vacant spaces must be filled up with small bushes, to represent the underwood. The whole wood should then be washed over with a lightish green; after which, the tops of the largest trees may be touched up with a darker green, and with a little brown or yellow, in order to produce that pleasing variety of tints which we so often behold and admire in nature.

Note 1.—When the Indian ink, composing the trees, is not perfectly dry, it will run in washing the wood with green; in order to avoid this, the green wash may be laid on before the trees and bushes are made.—This observation also points out the propriety of colouring fields, before the quickwood fences, are made with Indian ink.

2.—The tops of trees are formed in various ways. Sometimes they are made with jagged edges, and filled up in the middle with irregular strokes, in different directions; and some Surveyors form them entirely by horizontal lines of various lengths.

3.—When trees are small, and neatly made, it is unnecessary to touch them up with any colour.

4.—Quickwood hedges must be made with a pen and Indian ink, in imitation of bushes; and when trees are properly introduced, they have a very good effect in the hedge-rows. (See Plates IX. and XI.)

Lakes, Rivers, and the Sea-Shore.

Water must first be coloured with a fine tint of Prussian blue;

and then shaded, by a pen, and Indian ink, with crooked or waved lines, bold near the edges, and fainter towards the middle, as exhibited in No. 4, Plate VII., which is intended to represent a mere or lake.

Rivers and brooks must also be shaded with waved lines, continued from one end to the other, as represented in Plate XI.; and the sea-shore in a similar manner, but much stronger and bolder than either lakes or rivers.

Note 1.—Some draftsmen do not wash with Prussian blue, until they have finished shading with Indian ink; but it is much better to colour the water before it is shaded, as the ink frequently runs when a wash is laid upon it.

2.—Here it may not be improper to observe, that in colouring lakes, rivers, &c. with Prussian blue, the wash should be pretty strong at the edges, and softened off with water, towards the middle.

Hilly Ground.

Meadow and pasture ground should first be washed with a fine green, and ploughed land with a yellowish brown, as before directed; the hills must then be shaded in lines, with a pen and Indian ink, as represented in Nos. 5 and 6, Plate VII.

The sides of hills may be shaded in the manner represented in the lower part of No. 6; and when the top of a hill is level, it must be left almost without shade.

The greater the altitude of a hill, the deeper must be the shade; but the level part of a valley between two hills, must be very faintly shaded.

It will add greatly to the beauty of the plan or map, if all the hills be introduced in their proper places. When this is the case, and the hills are properly shaded, they form what is called a *bird's eye view;* it being supposed that the eye of the observer is elevated to some distance from the ground.

What has been said on this subject will be fully comprehended by the learner, if he carefully examine the Plate to which I have already referred; and also No. 5, Plate VI., which represents a high, moorish district, shaded in a very neat and expressive manner.

Pleasure Grounds.

In order to draw a true plan of pleasure-grounds, it is necessary to measure such lines, in taking the survey, as will enable you to lay down correctly, the shrubberies, grass-plots, and fish-ponds; the bases of summer-houses and alcoves; and the turnings and windings of all the gravel-walks, &c. &c.

The trees, bushes, bases of buildings, &c. &c. must then be neatly made; the fish-ponds and grass-plots properly coloured and shaded, as before directed, for lakes and meadows; and the gravel-walks washed with a fine brown inclining to yellow.

Note 1.—If the mansion-house, stables, gardens, &c. &c. be situated within the pleasure-grounds, the greatest care should be taken to lay them down correctly; as a gentleman will easily discover the smallest inaccuracy in a plan of those places with which he is so well acquainted.

2.—When pleasure-grounds are surveyed and planned with adjoining estates, the same scale must, of course, be used for the whole; but when the former are measured separately, a large scale should be chosen, in order to allow sufficient room to plan every object distinctly.

Gardens.

Gardens should be correctly and neatly planned; and finished in a tasteful and elegant manner.

The hot-houses, green-houses, grass-plots, gravel-walks, beds, &c. &c. should all be drawn and laid out, as they appear in the garden itself.

The divisions between the different beds may be made with short dashes, as represented in Nos. 3 and 4, Plate VI.; the beds should then be lightly shaded with a pen and Indian ink; rows of bushes inserted along the sides of the walks, and at the divisions of the various beds; and here and there a few scattered trees should be made, as before directed, if there be any in the garden.

The gravel-walks must then be washed with a yellowish brown; the grass-plots with green; and the different beds with a light tint of yellow, red, lake, blue, green, or any other colours, so as to produce a pleasing variety; and the trees may be touched up with a little dark green; and occasionally a brownish or yellowish tint may be used, to give them an autumnal appearance.

Note.—When plans are to be finished with colours, it is not necessary to shade them so much with Indian ink, as when they are finished with Indian ink only.

The Bases of Buildings.

The outlines of the bases of buildings must be made with a drawing-pen and Indian ink, bold and black on the south and east sides, or on the north and west sides; and the spaces in the middle filled up with oblique lines, as represented in No. 7, Plate VII., which is given expressly for the purpose of making the learner fully acquainted with the method of shading the bases of buildings, drawing the plans of villages, towns, &c. &c.

Note 1.—When a proprietor wishes to have a plan of his buildings, offices, yards, &c. &c. upon a large scale, the dimensions should be taken in feet and inches, or in feet and tenths, which is preferable; because the chains and tenths of a chain, upon the plotting-scale, may then be considered as feet and tenths, and used accordingly in planning; or when it is more convenient, each chain may be called ten feet; consequently, each division will then become one foot. (See Note 3, Prob. I. Part III.)

2.—When it is intended to lay down buildings by a large scale, the thickness of the walls, the lengths and breadths of rooms and passages, the widths of doors and windows, the projections of fire-places, and other necessary dimensions, should be taken, in order to produce a correct plan.

3.—After the base of a wall has been formed by parallel lines, drawn at such a distance from each other as to exhibit the wall's thickness, the space between these lines may then be shaded by oblique lines as before directed. The door-ways should be left open; the window-bottoms represented by omitting to shade them with oblique lines; the chimney-bottoms or fire-places exhibited by making the inside of the wall to project into the room, at right angles; and the steps of the stairs denoted by parallel lines, drawn at proper distances from each other. The insides of the rooms may either be left white or coloured, at the option of the draftsmen; and if it be thought tedious to shade the bases of the walls with oblique lines, they may be done with a brush and Indian ink.

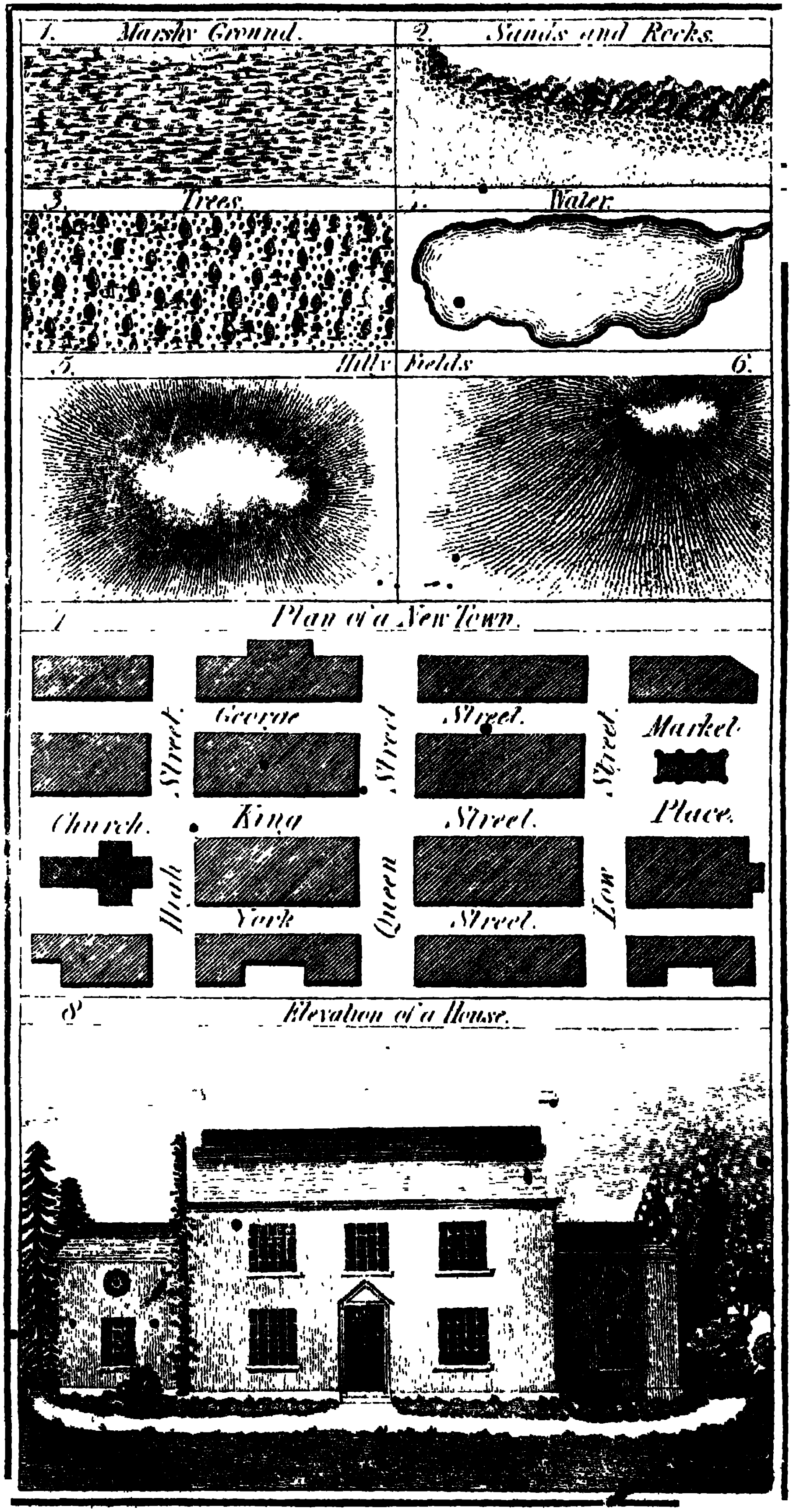
4.—The name of every room, office, yard, must be given, either within the rooms themselves, or in the margin of the plan; and when the premises are extensive, the names of the rooms, out-offices, yards, &c. will be numerous; there will probably be the kitchen, back-kitchen, parlour, hall, breakfast-room, dining-room, drawing-room, dairy, pantry, stairs, brew-house, wash-house, coal-house, carriage-house, stables, cow-house, calf-house, hog-stye, soil-hole, barn, stable-yard, court-yard, orchard, garden, &c. &c. What has been said on this subject will be easily comprehended by inspecting No. 2, Plate V.; which is the ground plan of a small house, laid down by a large scale, in order to show the learner how he must proceed with plans of a similar nature.

5.—When premises are to be sold, every convenience should be pointed out on the plan, in order to promote the sale; and it will be found very advantageous to have plans of the cellars, and the upper stories, and even the elevations; but this is more properly the business of an Architect than that of a Land-Surveyor. Some persons, however, will find it of considerable advantage to obtain a knowledge of both these sciences; as gentlemen frequently want not only plans of their estates, but also architectural draughts of their buildings.

The Elevations of Buildings.

In order to give a *perspective* view of the elevation of a building, it is necessary to be acquainted with the art of drawing in perspective; but an *architectural* view may be produced by taking the dimensions of the building, and laying them down by a scale of equal parts.

When it is intended to give the elevations of any buildings belonging to a farm, or the elevation of a mansion-house and offices belonging to a gentleman's estate, the length from end to end, the perpendicular height from the ground to the eaves, the height of the gable-ends, the height and breadth of the chimney-tops, the height and width of the doors and windows, their situations in the walls, and every other necessary dimen-


1. Marshy Ground.
2. Sands and Rocks.
3. Trees.
4. Water.
5. Hills
Fields 6.
7 Plan of a New Town.
George Street.
Market
Place.
Church.
King Street.
York Street.
High Street.
Queen Street.
Low Street.
8 Elevation of a House.

sion must be measured; then these dimensions being correctly laid down by a scale, will give an architectural view of the elevation of the building in question.

What has been advanced on this subject will be further illustrated by referring to No. 8, Plate VII., which is an architectural view of a gentleman's house, given for the inspection and improvement of the learner. The house itself is built with gable-ends, but the roofs of both the wings are hipped at one end, which make a pleasing contrast in the elevation.

Note 1.—After the outlines of an elevation are drawn, the common method of shading is by a brush and Indian ink; as it is generally thought too tedious to shade with strokes, in imitation of engraving. The roof should be shaded pretty strongly at the ridge, and softened off towards the middle, with water. It may then be washed with Prussian blue; and if the washes, both of Indian ink and colour, be light and often repeated; a more agreeable softness will be produced than by laying on only two or three strong washes. When the roof has been thus shaded, lines may be drawn parallel to the eaves, decreasing gradually in their distance from each other towards the ridge, to represent the edges of the slates. If the house be covered with tiles, the lines must be at equal distances from each other; because tiles of different sizes are never laid upon the same house.

2.—If the front of a building project beyond the wings, it must be denoted by making its shadow fall upon one of the wings; but if the wings project beyond the front, the shade of one of them must be made to fall upon the front. (See No. 8, Plate VII., where the shade of the front falls upon the right wing; if the wings had projected, the shade of the left wing would have fallen upon the front.)

3.—If a house be built of brick, it may be coloured red; if of stone, a colour may be chosen to resemble it; and when a roof is covered with grey slates, blue slates, or red tiles, it may be coloured accordingly. Sometimes the front of a building is shaded with Indian ink, the roof tinted with blue, and the stone door-posts, window-jambs, string-courses, chimney-tops, &c. &c. coloured so as to resemble stone. Indian ink, however, is generally used for fronts, in preference to any colour; as it is considered to give buildings a much richer appearance.

4.—If there be trees about the buildings, they may be *etched* with a pen and Indian ink, in imitation of engraving; the ground in front should be properly shaded; the gravel-walks coloured with a light brown; and if the elevation be bordered with black lines, as in No. 8, Plate VII., the sky may be coloured with a fine blue, or shaded with Indian ink.

5.—The elevations of buildings belonging to estates that have been surveyed, should be given on vacant parts of the plan, as embellishments; it is very seldom indeed that they are drawn in their true situations, because they would intercept the view of the ground plot; and besides, they are generally laid down by a much larger scale. The mansion-house of a nobleman, well executed, on a vacant part of the plan of his estate, has a very pleasing effect; and will never fail to gratify the proprietor.

6.—It is almost superfluous to remind the young draftsman that he should always keep his hands perfectly clean, and also cover his plans and maps with clean paper, (particularly under his hands,) to preserve them from being in the least soiled in drawing them; as nothing exhibits the carelessness of a draftsman in a more conspicuous light, than seeing his work besmeared with dust, ink, or colours.

METHOD III.

Plans highly finished with Indian ink.

A plan highly finished with Indian ink only, has a very elegant appearance, and is considered, by most persons, to excel those done in colours; but the process is very tedious, and requires much time to do it neatly; however, if the Surveyor be well paid for his time, he ought to finish his plans in that manner which is most likely to give satisfaction to his employers.

Many Surveyors keep plans by them, finished in various ways, as specimens, in order that gentlemen may have an opportunity of choosing in what manner they will have the plans of their estates executed.

Shading with the Pen.

In finishing a plan with Indian ink, a fine pen ought to be used; and the fields should be shaded in a great variety of forms, in imitation of engraving, as exhibited in Plates V. IX. and XI.

Some fields should be done lighter, and others darker, so as to produce a pleasing contrast of light and shade. Some may be executed in such a manner as to resemble corn-fields, as in Nos. 1 and 6, Plate IX.; and 13 and 16, Plate XI.; and others may be shaded like meadow and pasture, as exhibited in Nos. 1 and 2, Plate VI.

High, moorish ground should be shaded as represented in No. 5, Plate VI.; and marshy ground, sands, loose stones, rocks, trees, water, hilly fields, and the bases of buildings, as denoted in Plate VII.; and even the elevations of buildings look very elegant, when they are finely shaded with lines, as No. 8, in the Plate to which we last referred.

Note.—In finishing a plan with Indian ink only, it is necessary to shade it much closer and deeper, than in finishing with Indian ink and colours.

Penmanship.

In making finished plans, no ornaments or embellishments will compensate for bad penmanship.

Writing, German-text, Printing, and Figures, are all essentially necessary for a draftsman; and whoever would excel in the art of planning, should use his utmost endeavours to become a complete and elegant penman.

He should practise the various hands, either by copies well written, or by good copper-plates, until he can make all the letters and figures correctly, and with true taste; and it will save him much trouble in making compartments and devices, if he can acquire the art of flourishing and ornamenting neatly and elegantly with the pen. *(See Notes 3, 4, 5, and 6, page 378.)*

Ornaments.

Any compartment or device may be chosen to fill up the vacant corners of a plan, such as the compass, scrolls of paper, wreaths or festoons of leaves and flowers, branches or sprigs of oak, palm-tree, weeping-willow, myrtle, laurel, olive, &c. &c. Also shields, coats of arms, columns supporting vases or urns, mathematical instruments, cattle, sheep, or whatever else may please the fancy of the draftsman.

Ornaments on Plate IX.

In the N. W. corner is a device formed of an oak branch, leaves, and acorns on the left side; and on the right side is a branch of large pointed leaves resembling sedges or sweet flags, intertwined with a string of small leaves; and both branches are united at the bottom by a bunch of riband.

In the S. W. corner is a scroll of paper, supported by a fluted column; by the side of which are some ears of corn, and at the bottom a few blades of grass and herbage.

In the N. E. corner is the sun in his meridian splendour, with a fancy device resembling an ogee cornice, fronted with reeds; and from each end of the cornice is suspended a festoon of small leaves.

In the S. E. corner is a plotting-scale; a pair of compasses, two drawing-pens, and a writing-pen, interwoven with a garland of small leaves and berries, resembling those of the myrtle.

Ornaments on Plate XI.

In the N. W. corner is a fancy device, in the form of an oval; and in the N. E. corner is a rectangular device, with the exception of the arch at the top. This device is ornamented with a bunch of riband, and two festoons of small leaves and berries, hanging upon two scutcheons, or shields.

In the S. W. corner is a column, at the top of which is a vase encircled with leaves and flowers. On the west of the column, Britannia is seated, leaning on her shield, holding a spear in her right-hand, and with her left-hand pointing out the science of Surveying. To the east of the column are two sheep, emblems of agriculture.

The plotting-scale, drawing-pens, &c. are nearly similar to those in the last plate.

In the S. E. corner is a parallel ruler, a plane table, a terrestrial globe, a crowing cock, and a youth seated upon a bee-hive, with a pair of compasses in his hand, at work upon Plate XII.

The cock is an emblem of early rising, and the bee-hive may be considered as an emblem of industry; and it may here be remarked that it is impossible to attain eminence in the art of Surveying, without early rising, industry, and perseverance.

MISCELLANEOUS INSTRUCTIONS

RELATING TO

SURVEYING, PLANNING, CASTING, VALUING, &c. &c.

1. THE title of a plan should set forth the name of the proprietor; and also the name of the township, hamlet, parish, and county, in which the estate is situated.

2. The names of the adjoining lordships, or the names of the proprietors of the adjoining lands, should be given on the plan, in order to point out clearly the situation of the estate, and corroberate the title,

3. All principal roads passing through the estate, from one highway to another, should be laid down; and the places to which they lead, specified.

4. All foot-paths and bridle-roads should be pointed out, in order to determine the public right; and guard against encroachments.

5. All occupation and privileged roads, through adjoining estates, should be noticed either on the plan, or in the reference-book.

6. All ancient highways, leading through the estate, although not now in use, should be particularly specified, and the names of the proprietors given, to show in whom the privilege of re-opening them, if necessary, is vested.

7. The ancient and proper names of fields should be preserved; as it generally creates confusion and mistakes, when new ones are assigned without sufficient authority.

8. It has already been observed, that the extremities of the ditches are generally the boundaries between adjoining fields; this, however, is not always the case, as the stem of the quick-wood sometimes forms the boundary; hence the necessity of obtaining an assistant who is well acquainted with all the local customs of the place.

9. The greatest care must be taken to find the area of each field correctly; and particularly if the survey be taken for an inclosure, or to make a valuation for the land-tax, poor-rates,

county-rates, and other assessments; for it is evident that if the survey be incorrect, the valuation can never be equitable; and will consequently produce nothing but disputes and dissatisfaction among the proprietors and occupiers, instead of peace, harmony, and friendship.

10. In valuing for an assessment, great care should be taken not to over-rate the land that is of a poor quality, and lies far from the means of improvement; for bad land costs the occupier as much in labour and seed, as good land, and is far less productive. (See more observations on valuing land, in Part VI.)

11. In reducing a plan for portable use, care should be taken to choose a scale sufficiently large to exhibit all the irregularities in the fences, buildings, &c.

12. Several small farms, or detached pieces of land, belonging to one proprietor, may be laid down upon the same sheet. They ought not, however, to be joined together, but planned as separate estates.

13. When one sheet of drawing-paper is too small to contain the survey, two or more must be neatly pasted together; and when those parts that have been wet with the paste, are nearly dry, they may be made smooth by a warm *iron*. The edge of one of the sheets should be cut even, and laid nearly half an inch over the edge of the other sheet; and a piece of clean paper should be laid under the *iron*, to prevent it from soiling the plan.

14. It has already been observed that the surveying-chain should frequently be measured. The readiest method of doing this, is to drive two stakes or pins into the ground, exactly at the distance of 22 yards from each other. Professional Surveyors measure their chains in this manner every morning, when they are engaged in extensive measurements. When the chain has become too long, it is better to cut a little from several of the links, than to take off the rings; care, however, must be taken to keep each 10 links of an equal length, or the dimensions will be incorrect.

15. The book of particulars, before-mentioned, is generally called "A Terrier of the Survey," and should contain references corresponding to those upon the plan; also the name of each

field, or the name of the proprietor, or of the occupier; and the area of each field, in acres, roods, and perches. If the Surveyor value the estate, the Terrier ought to contain the value per acre to let, or for sale; the annual value of each field to let, or the total value for sale; and also the cultivation of each field: thus will the proprietor be furnished with every necessary particular relating to his estate.

16. The Terrier may likewise contain remarks and observations on the quality of the soil; and point out the method of improving wet marshy grounds, by draining them; commons and waste lands, by inclosing them; large fields, by dividing them; &c. &c.

17. Some Surveyors return three measurements of each field in the Terrier; viz. the land in cultivation; the hedges and waste land; and the total quantity, or sum of both.

18. In giving the cultivation of each field, the permanent meadows, or those which the tenant is prohibited from breaking up, should be particularly noticed.

19. In writing out a valuation-book for the purpose of making assessments, all the lands and tenements in the occupation of the same tenant, should be collected together; and put down on the left-hand page of the book. At the top of the page must appear the name of the tenant; and in the first and second columns respectively, the names of the proprietors and the numbers on the plan. The third, fourth, fifth, and sixth columns, must contain the name, measurement, value per acre, and total value of each field respectively. The right-hand page may be left blank for incidental remarks, when a change of occupation takes place; or when any circumstance occurs that affects the arrangement of the book.

20. When the valuation is high, it is frequently thought prudent to calculate the assessments from one-fourth, one-half, or three-fourths of the amount; this, however, is more properly the consideration of the occupiers, than that of the Land-Surveyor. Sometimes the assessments are calculated from one-half, or three-fourths of the valuation of the land; and from one-fourth of the valuation of the buildings.

A TERRIER OF THE SURVEY IN PLATE IX.

Nos. on the Plan.	Names of the Fields.	Cultivation of the Ground.	Area in			Value per Acre to rent.			Total Value per Annum to rent.		
			A.	R.	P.	£.	s.	d.	£.	s.	d.
1	Calf Garth	Pasture	1	0	20	2	12	6	2	19	0¾
2	Lane Close	Arable	2	2	38	1	16	0	4	18	6½
3	Low Close......	Permanent Meadow	2	0	10	2	2	6	4	7	7¾
4	Turnpike Close	Arable	13	1	28	1	14	0	22	16	5¼
5	Daisy Field	Meadow	11	0	9	1	15	6	19	12	5¾
6	Triangle	Pasture	12	2	18	2	3	6	27	8	7½
	Sum Total		43	0	3	....			82	2	9½

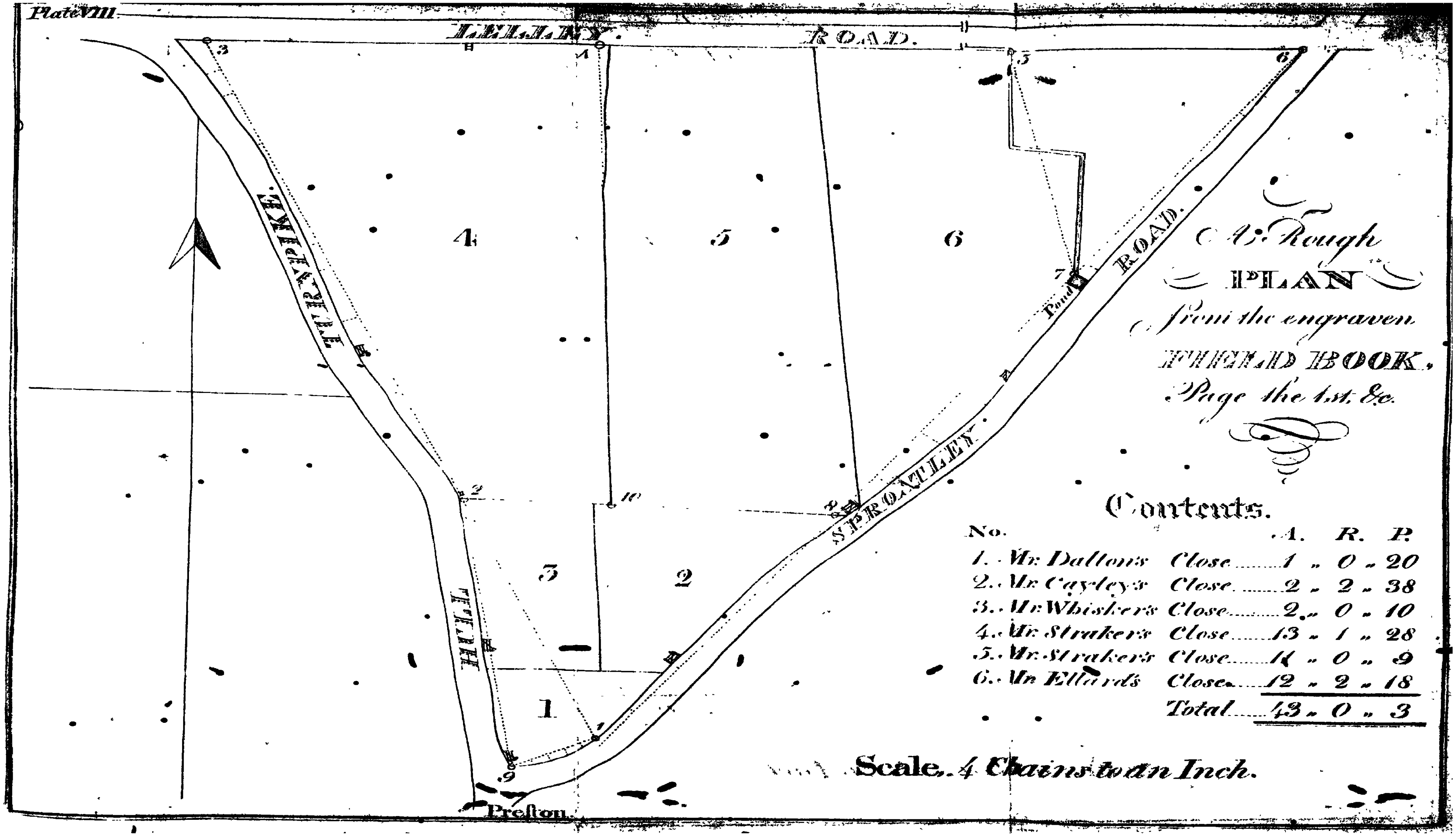
Note 1.—The annual value of each field may be found from the area, and the value per acre, by the Rule of Three; but when the calculations are numerous, much labour may be saved by using Hudson's Land Valuer's Assistant.

2.—If one tenant occupy all the foregoing estate, his rent will be 82*l.* 2*s.* 9½*d.* per annum; and if the assessments be made from three-fourths of the annual value, he will be assessed at 62*l.* 12*s.* 1*d.*

3.—The Terrier may be divided into any number of columns, to suit the purpose of the Surveyor; and when the observations, remarks, &c. are too numerous to be contained in the columns of one page, each two opposite pages may be divided into columns, in which may be entered every necessary information relating to the estate.

4.—In extensive surveys and valuations, an alphabetical index should be annexed to the Terrier or Valuation-Book, in order that the name of any particular proprietor or occupier may be more readily found.

Plate VIII.



A Rough
PLAN
from the engraven
FIELD BOOK,
Page the 1st, &c.

Contents.

No.		A.	R.	P.
1. Mr. Dalton's	Close	1	0	20
2. Mr. Cayley's	Close	2	2	38
3. Mr. Whisker's	Close	2	0	10
4. Mr. Straker's	Close	13	1	28
5. Mr. Straker's	Close	11	0	9
6. Mr. Ellard's	Close	12	2	18
	Total	43	0	3

Scale, 4 Chains to an Inch.

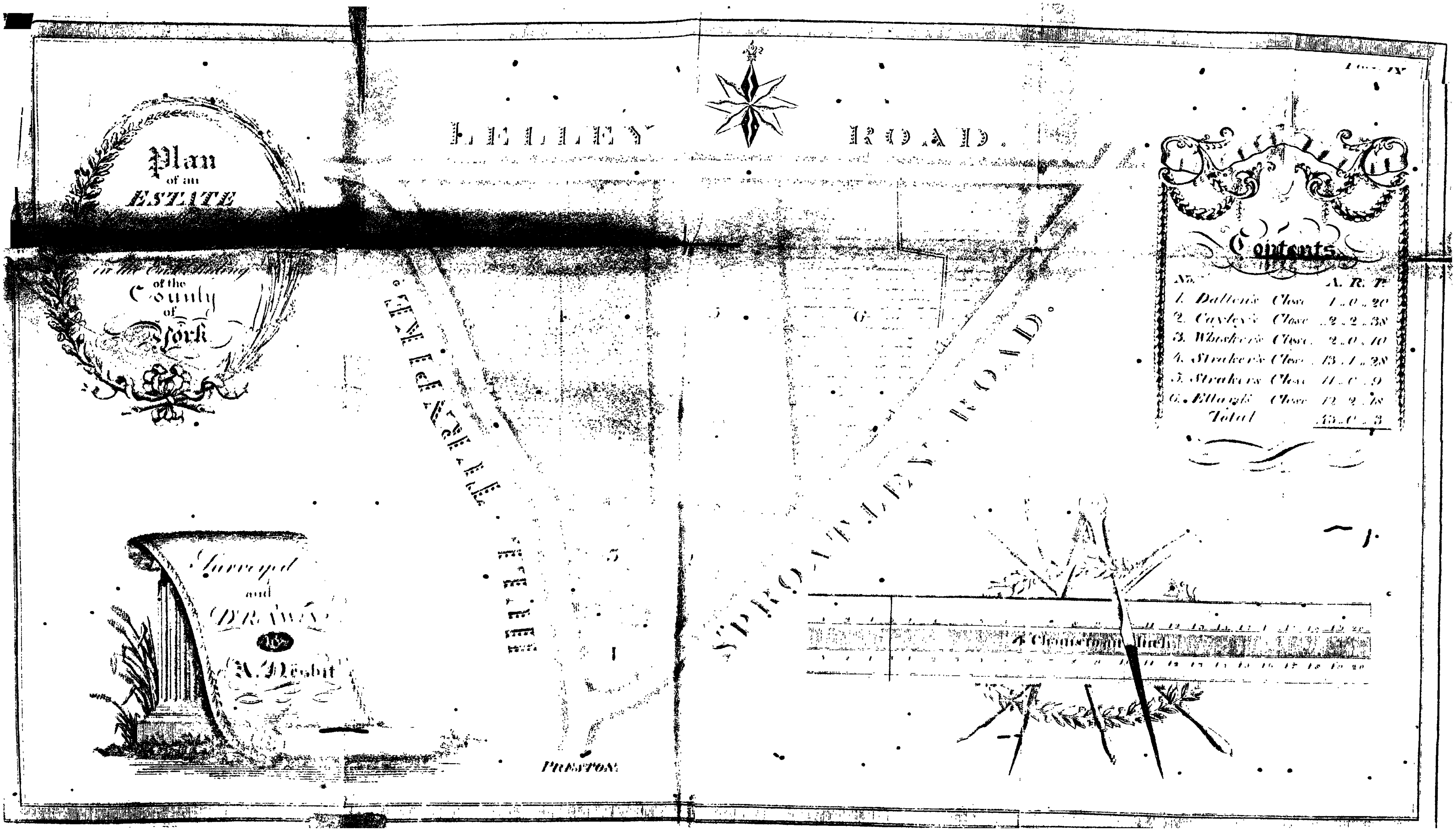
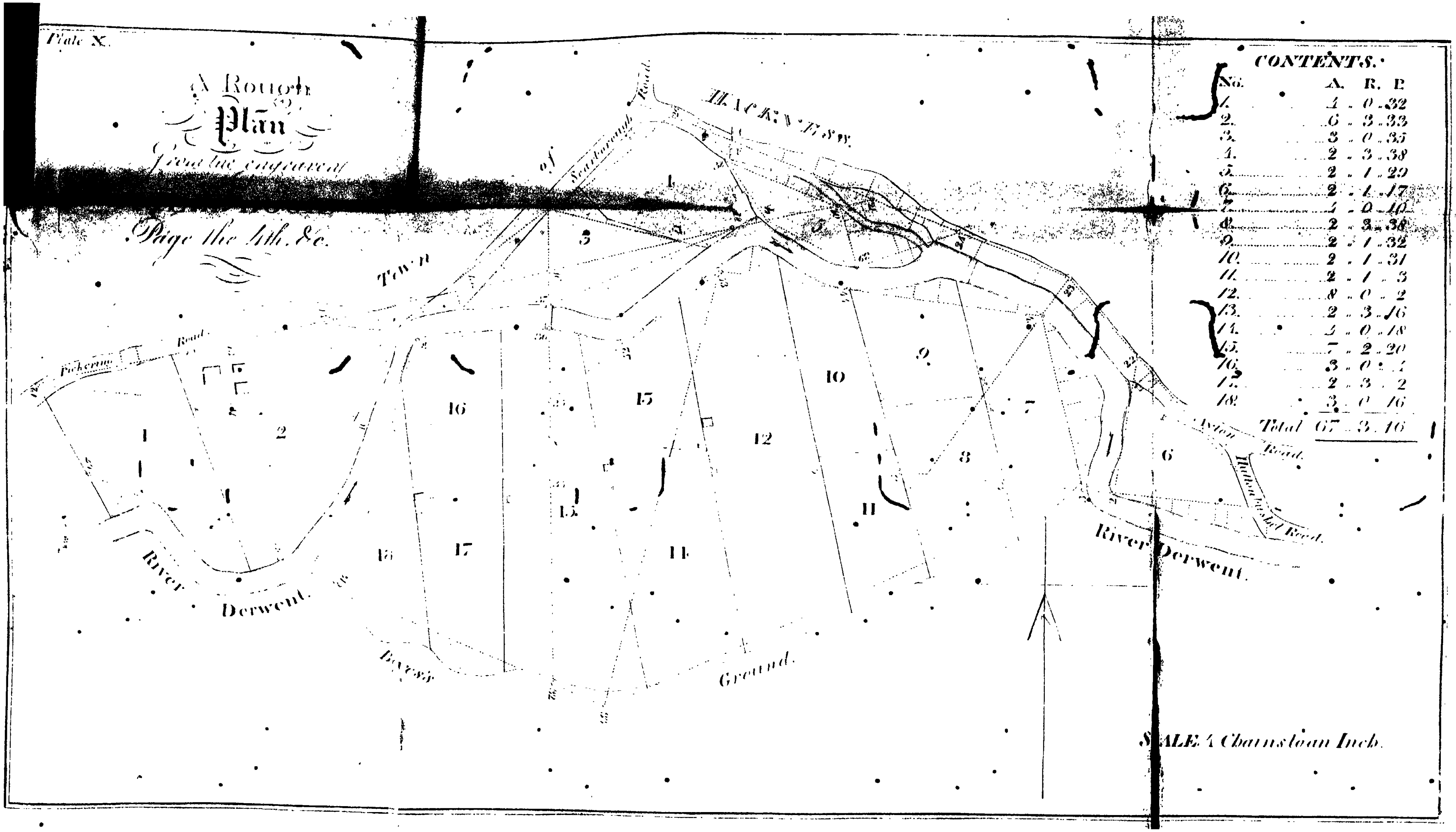

IX
Plan
of an
ESTATE
of the
County
of
York
LELLEY ROAD.
SPROATLEY ROAD.
PRESTON
1
4
5
6
Contents
No.
A. R. P.
1. Dalton's Close 1 . 0 . 20
2. Cayley's Close 2 . 2 . 38
3. Whekere's Close 2 . 0 . 10
4. Straker's Close 13 . 1 . 28
5. Strakers Close 11 . 0 . 9
6. Ellaugh Close 12 . 2 . 18
Total 45 . 0 . 3
4 Chains to an Inch
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Surveyed
and
DRAWN
by
R. Nesbit

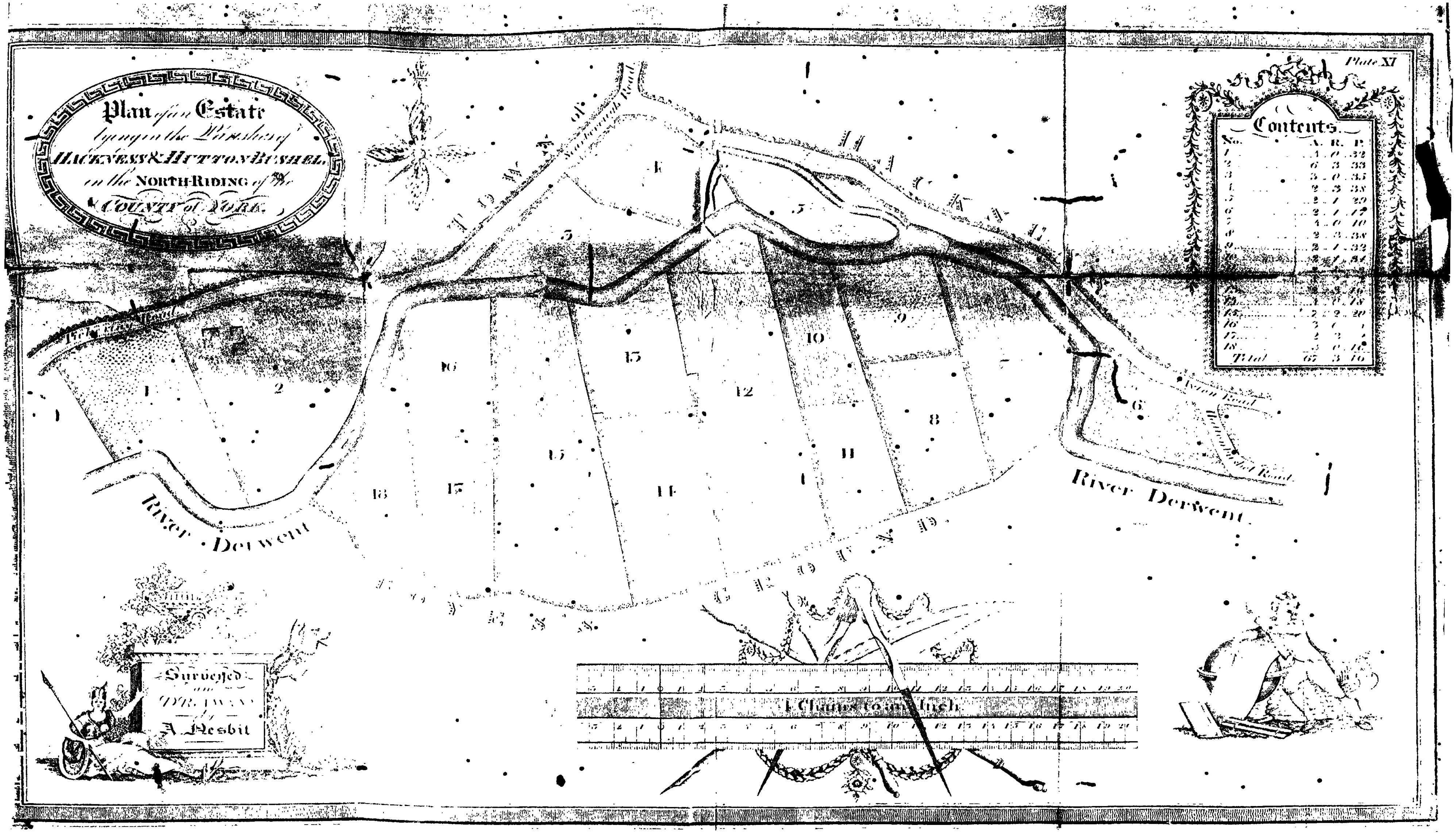
Plate X.

A Rough
Plan
from the engraved
Page the 4th. &c.



CONTENTS.

No.	A.	R.	P.
1.	4	0	32
2.	6	3	33
3.	3	0	35
4.	2	3	38
5.	2	1	29
6.	2	1	17
7.	4	0	10
8.	2	3	38
9.	2	1	32
10.	2	1	31
11.	2	1	3
12.	8	0	2
13.	2	3	16
14.	4	0	18
15.	7	2	20
16.	3	0	4
17.	2	3	2
18.	3	0	16
Total	67	3	16



Contents.

No.	A.	R.	P.
1	1	0	32
2	6	3	33
3	3	0	35
4	2	3	38
5	2	1	29
6	2	1	17
7	4	0	10
8	2	3	38
9	2	1	32
10	2	1	34
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
13	2	3	16
14	1	0	18
15	2	2	20
16	3	0	1
17	2	2	[illegible]
18	3	0	16
Total	67	3	16

LAND-SURVEYING.

Part the Sixth.

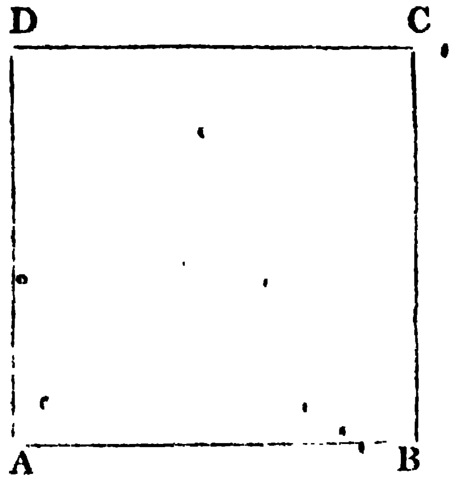
Rules and Directions for laying out any given Quantity of Land, in any proposed Figure; for parting from any Field or Figure any Quantity of Land required; and for dividing a Piece of Land among sundry Claimants in the Proportion of their respective Claims, or a Common, &c. of variable Value, among any Number of Proprietors, in the Proportion of their respective Interests. Also, the Method of reducing Statute Measure to Customary, and vicè versâ.

SECTION I.

RULES AND DIRECTIONS FOR LAYING OUT ANY GIVEN QUANTITY OF LAND, IN ANY PROPOSED FIGURE; AND FOR PARTING FROM ANY FIELD OR FIGURE, ANY QUANTITY OF LAND REQUIRED.

When the land to be laid out, or parted off, is given in acres, roods, and perches, it must first be reduced into square links; in which process the following Table will be found extremely useful.

When it is required to part off from any field, or figure, any quantity of land, it is generally necessary, first, to measure the whole, if the dimensions be not given.



In laying out the square, in the field, let A B represent one of its sides, which make = 860.2 links. At A, erect the perpendicular A D, which make = A B; and at B, erect the perpendicular B C, which make also = A B. Then measure the line C D, and if you find it = 860.2 links, the work is right.

2. Required the side of a square, which shall contain 15 acres, 2 roods, and 32 perches. Ans. 1253 links.

PROBLEM III.

Upon a given Line, to make a Rectangle, that shall contain any proposed Quantity of Land.

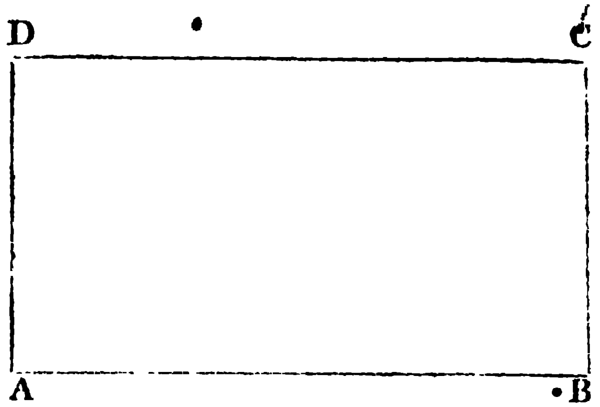
Rule.—Divide the proposed area by the given side, and the quotient will be the other side of the rectangle.

EXAMPLES.

1. Lay out 3A. 3R. 26P. in the form of a rectangle, one side of which must be 850 links.

sq. links.
3A. = 300000
3R. = 75000
26P. = 16250

85,0)39125,0(460.3 links, the other side.
340
512
510
250
255



In laying out the rectangle in the field, let A B represent the given side. At A, erect the perpendicular A D, which make = 460.3 links; and at B, erect the perpendicular B C, which make = A D. Then measure the line C D, and if you find it = A B, the work is right.

2. If one side of a rectangle be 525 links; required the other side, so that the figure may contain 6A. 2R. 23P.

Ans. 1265.5 links.

PROBLEM IV.

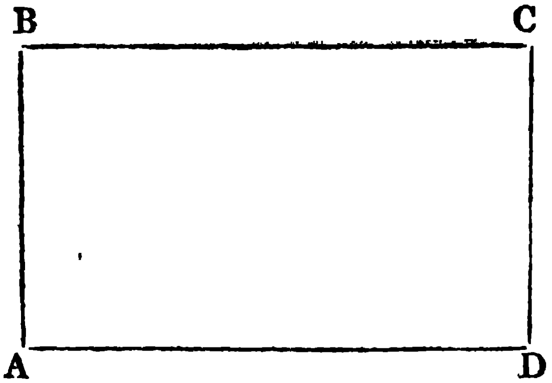
To lay out any given quantity of Land in a Rectangle, so that one of its Sides shall be two, three, four, or any number of times as long as the other.

Rule.—Divide the given area by the given number, and the square root of the quotient will be the shorter side, which multiply by the given number, and the product will be the longer side.

EXAMPLES.

1. Lay out 3A. 0R. 32P. in the form of a rectangle, one of the sides of which shall be twice as long as the other.

sq. links.
3A. = 300000
32P. = 20000
2)320000
160000(400 links, the shorter side.
16 2
··0000 800 links, the longer do.



Let A B C D represent the rectangle, which you must lay out according to the directions in the last problem; A D being 800, and A B 400 links.

2. A rectangle contains 7A. 2R. 0P.; what are its sides, one of them being three times the length of the other?

Ans. 1500 and 500 links.

PROBLEM V.

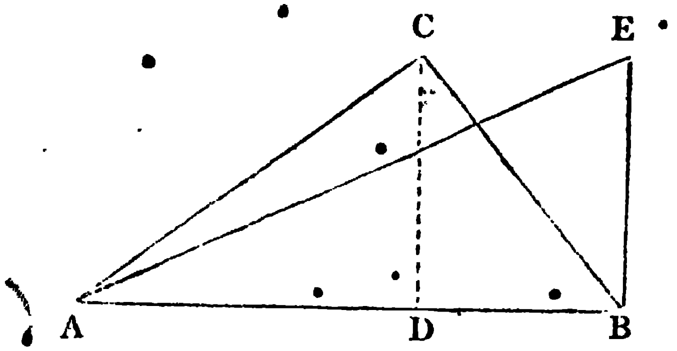
Upon a given Base, to lay out a Triangle that shall contain any given number of Acres, &c.

Rule.—Divide the area by half the base, or twice the area by the whole base, and the quotient will be the perpendicular of the triangle.

EXAMPLES.

1. Lay out 3A. 2R. 16P. in the form of a triangle, the base of which must be 1200 links.

sq. links.
3A. = 300000
2R. = 50000
16P. = 10000
6,00)3600,00
600 links, the perpendicular.



Upon any part of the given base A B, suppose at D, erect the perpendicular D C, which make = 600 links; then stake out the line A C and B C; so will A B C be the required triangle. But if the perpendicular be erected at either end of the base, as at B, then the line A E must be staked out; and A B E will be the triangle required.

2. Required the perpendicular of a triangle, which contains 6A. 2R. 37P., its base being 1556 links. Ans. 865.2 links.

PROBLEM VI.

To lay out a Trapezium, that shall contain any Number of Acres, &c.; having one of its Sides or a base Line given.

RULE 1.—Divide the given area into two parts, either equal or unequal; and then, by the last problem, find the perpendicular that will lay out one of these parts in a right-angled triangle, upon the given base.

You must then consider this perpendicular as one of the diagonals of the trapezium, and also the base upon which you must lay out the other triangle.

RULE 2.—Divide the given area into any two parts, as before; and then, find the perpendicular that will lay out one of these parts in a right-angled triangle, upon the given base.

Add the square of the perpendicular thus found, to the square of the given base, and the square root of the sum will be the hypothenuse. Consider this hypothenuse as one of the diagonals of the trapezium, and also the base upon which the other triangle must be laid out.

EXAMPLES.

1. Lay out 8A. in a trapezium, upon a given side of 800 links.

BY THE FIRST RULE.

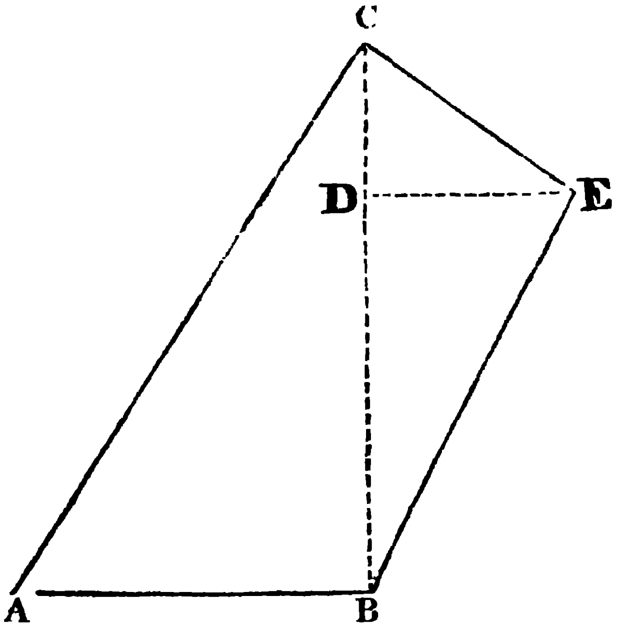
Divide the given area into 5 and 3 acres, and let the triangle upon the given side contain the greater part.

5A. = 500000 square links.

8,00|10000,00
1250 links, the perpendicular of the first triangle, and also the base of the second.

3A. = 300000 square links.
2

125,0)60000,0(480 links, the perpendicular of the second triangle.
500
1000
1000
....0



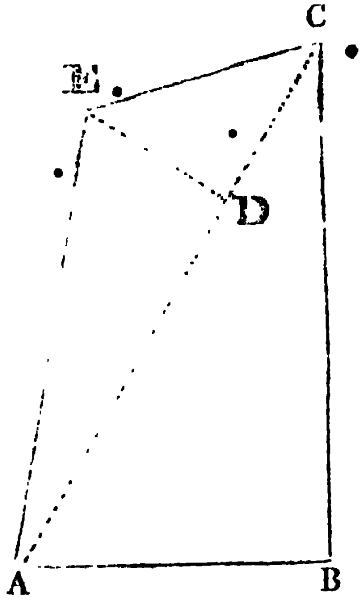
In laying out the trapezium, in the field, let A B represent the given side. At B, erect the perpendicular B C, which make = 1250 links. Then, upon any part of the line B C, as at D, erect the perpendicular D E, which make = 480 links. The four outlines being properly staked out, the work will be completed.

BY THE SECOND RULE.

5A. = 500000 square links.
2
8,00)10000,00
1250 links, the perpendicular of the first triangle.

Then, $\sqrt{1250^2 + 800^2} = \sqrt{1562500+640000} = \sqrt{2202500}$ = 1484 links, the hypothenuse of the first, and also the base of the second triangle.

3A. = 300000 square links.
2
1484)600000(404.3 links, the perpendicular of the second triangle.
5936
6400
5936
4640
4452
188



Having laid out the triangle A B C, as before directed; upon any part of the line A C, as at D, erect the perpendicular D E, which make = 404.3 links. Stake all the outlines, and the work will be completed.

2. Lay out 12A. in a trapezium, upon a given side of 1400 links.

Ans. Supposing the given area divided into 7 and 5 acres;

then, by the first Rule, the perpendicular of the first triangle is found to be 1000 links; and that of the second the same.

By the second Rule, the perpendicular of the first triangle is found to be 1000 links; the base of the second 1720.5, and its perpendicular 581.2 links.

PROBLEM VII.

Upon a given Base, to lay out a Rhombus of any Content less than the Square of the Base.

RULE.—Divide the content by the base, and the quotient will be the perpendicular. Then, from the square of the base, subtract the square of the perpendicular, and find the square root of the remainder. Upon the base, from one of its extremities, measure a line equal to this root, and at this point erect a perpendicular.

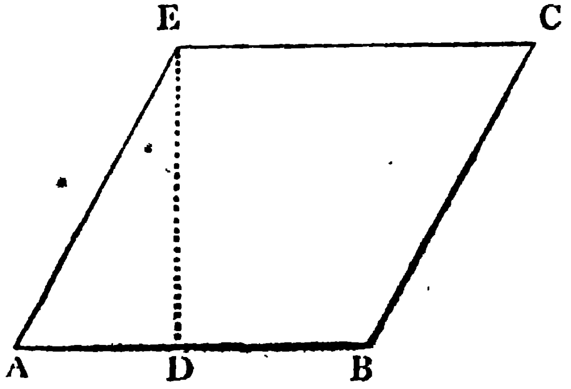
Note.—It is evident from the foregoing Rule, that the area of a rhombus or rhomboides may be found by multiplying the base by the perpendicular breadth.

EXAMPLES.

1. Lay out in a rhombus, 5A. 2R. 16P. its base being 800 links.

sq. links.
5A. = 500000
2R. = 50000
16P. = 10000
8,00|5600,00
700 links, the perpendicular.

Then, $\sqrt{800^2-700^2}=\sqrt{640000-490000}=\sqrt{150000}=387.3$ links, at which distance, from one of the extremities of the base, the perpendicular must be erected.



In laying out the rhombus, in the field, let A B represent the given base. From A, on the line A B, measure 387.3 links to D; and at D erect the perpendicular D E, which make = 700 links. At E, erect the perpendicular E C, which make = the base A B. Measure the lines C B and A E, and, if you find each of them = A B, the work is right.

2. Lay out a rhombus, which shall contain 6A. 1R. 8P., upon a base measuring 900 links.

Ans. The perpendicular is found to be 700 links, and the distance at which it must be erected from one of the extremities of the base 565.7 links.

PROBLEM VIII.

To lay out any given Quantity of Land in a Circle.

RULE 1.—If we multiply the square of the diameter of any circle by .7854, the product will be the area; consequently, if we divide the area by .7854, the quotient will be the square of the diameter.

2. Multiply the square root of the area by 1.12837, and the product will be the diameter.

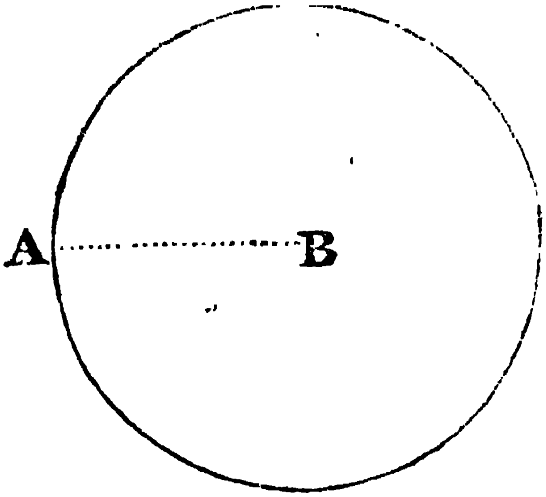
EXAMPLES.

1. Lay out one acre of land in a circle.

```
          sq. links.
.7854)100000.000000(127323.65 links, the square of
      7854                         the diameter.
      21460
      15708
      ·57520
       54978
       ·25420
        23562
        ·18580
         15708
         ·28720
          23562
          ·51580
           47124
           ·44560
            39270
            ·5290
```

Then, $\sqrt{127323.65} = 356.82$ links, the diameter of a circle containing one acre of land.

Or, by the Second Rule, $\sqrt{100000} = 316.227$; and $316.227 \times 1.12837 = 356.82$ links, the diameter, as before.



In laying out the circle in the field, provide a strong cord, in length equal to the radius of the circle, which in this case will be 178.4 links; and fixing one of its ends at B, as a centre, make the other fast to your offset-staff, near its lower extremity. Then, stretch the cord to A, and, with the line A B, describe the circle, keeping the staff perpendicular, and making a mark on the ground, with its pike, by which you must stake out the circumference.

Or, at proper intervals, stretch the radius A B, and put down stakes in such a manner as to form the circumference.

2. Required the diameter of a circle, which will contain half an acre of land. Ans. 252.3 links.

PROBLEM IX.

To lay out any given Quantity of Land in a regular Polygon.

Rule.—Divide the area of the required polygon, by the area standing opposite to its name, in the subjoined Table, and the square root of the quotient will be the length of the side. Multiply the side thus found, by the polygon's number, in the column of radii, and the product will be the radius of the circle circumscribing the required polygon.

A Table of regular Polygons, with their Areas; and the Radii of their circumscribing Circles, when the side of the Polygon is 1.

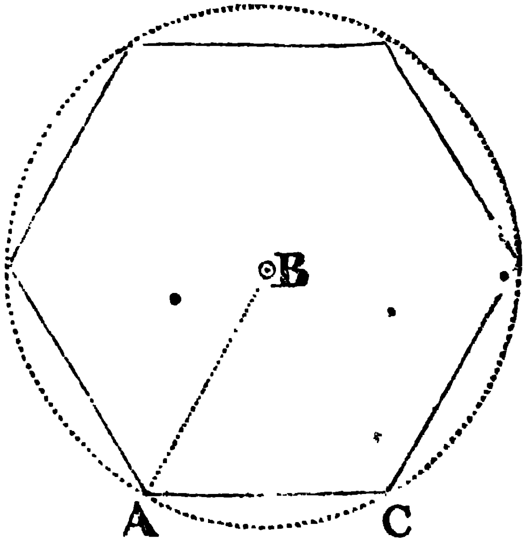
No. Sides.	Names.	Areas.	Radii.
3	Triangle	0.433	0.577
4	Square	1.	0.707
5	Pentagon	1.72	0.851
6	Hexagon	2.598	1.
7	Heptagon	3.634	1.152
8	Octagon	4.828	1.306
9	Nonagon	6.182	1.462
10	Decagon	7.694	1.619
11	Undecagon	9.365	1.775
12	Duodecagon	11.196	1.932

Note.—If the square of the side of any polygon, be multiplied by the area standing opposite to its name, in the preceding Table, the product will be the area of the polygon.

EXAMPLES.

1. Lay out one acre of land in a regular hexagon.

Here $\frac{100000}{2.598} = 38491.147$; and $\sqrt{38491.147} = 196.191$ links, the side of the required polygon, and also the radius of the circumscribing circle, because the side of a regular hexagon and the radius of its circumscribing circle are always equal to each other; hence the multiplier in the Table is 1.



To lay out the hexagon, in the field, draw the circumscribing circle as directed in the last problem. Then, the radius A B, which is equal to the side of the hexagon, being applied six times, will just go round the circumference, and form the polygon required.

2. Lay out half an acre of land in a regular octagon.

Ans. The side of the required octagon is 101.76, and the radius of its circumscribing circle 132.898 links.

PROBLEM X.

To lay out any given Quantity of Land, in an Ellipsis, having one of the Diameters given.

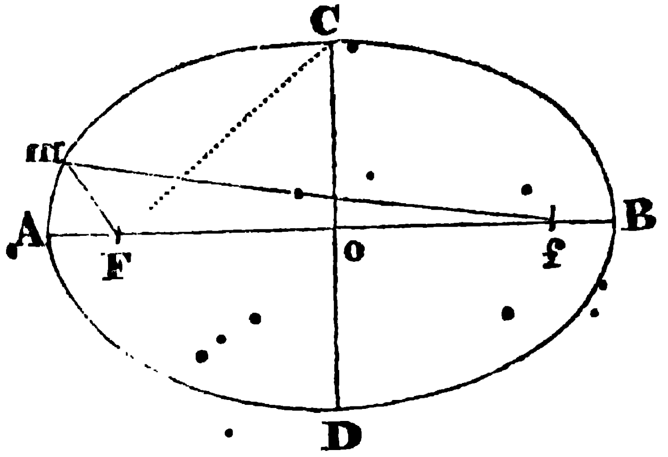
RULE.—If we multiply the rectangle of the two diameters of an ellipsis by .7854, the product will be the area; consequently, if we divide the area by .7854, and that quotient by the given diameter, the latter quotient will be the diameter required.

EXAMPLES.

1. Lay out an ellipse, which shall contain one acre, with a transverse diameter of 450 links.

sq. links.
.7854)100000.00000(127323.6 quotient.
78.54
21460
15708
57520
54978
25420
23562
18580
15708
28720
23562
51580
47124
4456

Then, $\frac{127323.6}{450} = 283$ links, the conjugate diameter.



By Prob. 15, Part I., construct the ellipse A B C D; then by a property of the ellipse, (see my Mensuration, page 318,) the square of the distance of the focus from the centre, is equal to the difference of the squares of the semi-diameters: hence, we have $\sqrt{225^2 - 141.5^2} = \sqrt{30602.75} = 175$ links, equal F o, or f o: and, $225 - 175 = 50$ links, equal A F, or B f.

Again, by another property of the ellipse, the sum of two lines drawn from the foci, and meeting in any point in the circumference, is equal to the transverse diameter; that is, F m + f m = A B.

Procure, therefore, a cord, and upon it make two loops, so that the distance between them may be equal to the transverse diameter; then measure, in the field, the diameter A B; putting down a stake at each focus, and one at the centre o. At o, erect the perpendiculars o C and o D, making each = 141.5 links.

Put the two loops over the stakes at F, f, and stretch the cord, so that the two parts F m, f m, may be equally tight; at m put down a stake, as one point in the circumference of the ellipse; and, in the same manner, determine as many others as you please.

But if the ellipse be very large, so that you cannot conveniently procure a cord as long as the transverse diameter; you must then erect perpendiculars, called ordinates, at every 50 links, or at every chain's length, &c. upon that diameter, and measure the lengths of these perpendiculars by the scale.

Then measure, in the field, the transverse and conjugate diameters, and erect the perpendiculars in their proper places; always remembering to put down a stake at the end of each perpendicular.

2. Lay out an ellipse which shall contain 8A. 3R. 8P., one of the diameters being given equal to 800 links.

Ans. The other diameter is = 1400 links.

Note.—As Surveyors are frequently requested to lay out, in various figures, small quantities of land for plantations, &c. it is presumed that the foregoing problems will be found not without their use.

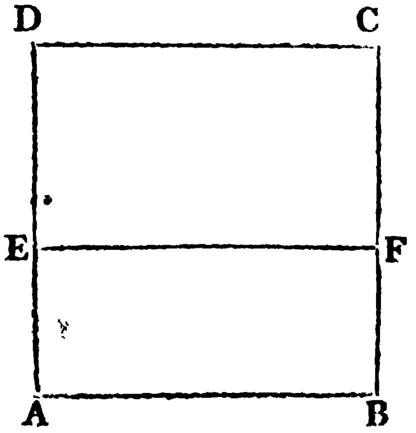
PROBLEM XI.

To part from a Square or Rectangle, any proposed Quantity of Land, by a Line parallel to one of its sides.

Rule.—Divide the proposed area by the side upon which it is to be parted off, and the quotient will be the length of the other side of the figure required.

EXAMPLES.

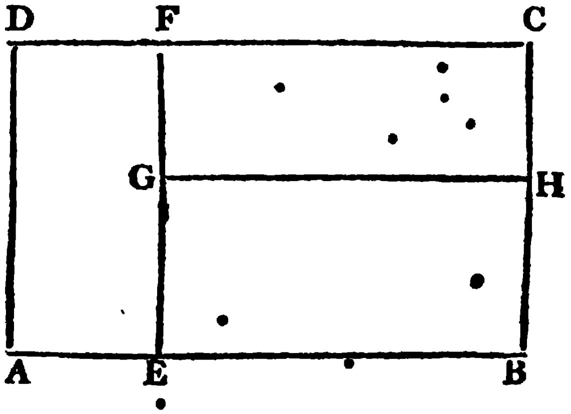
1. From the square A B C D containing 6A. 1R. 24P., part off 3A. by a line parallel to A B.



sq. links.
6A. = 600000
1R. = 25000
24P. = 15000
640000(800 links, the side of the square.
64
0000

Then, $\frac{300000}{800}$ = 375 links, the side A E, or B F required.

2. From the rectangle A B C D containing 8A. 1R. 24P., part off 2A. 1R. 32P. by a line parallel to A D = 700 links. Then, from the remainder of the rectangle, part off 2A. 3R. 25P. by a line parallel to A B.



sq. links.
2A. = 200000
1R. = 25000
32P. = 20000
7,00|2450,00
350 links, the side A E, or D F.

sq. links.
8A. = 800000
1R. = 25000
24P. = 15000
7,00|8400,00
1200 links, the side A B.
350 —— the side A E.
850 —— the difference = E B.

sq. links.
2A. = 200000
3R. = 75000
25P. = 15625

850)290625(342 links, the side E G, or B H.
2550
3562
3400
1625
1700

3. Part off 6A. 3R. 12P. from a rectangle, containing 15A. by a line parallel to the longer side; the shorter being 1000 links.

Ans. The longer side of the given rectangle is 1500, and the shorter side of the rectangle required is 455 links.

PROBLEM XII.

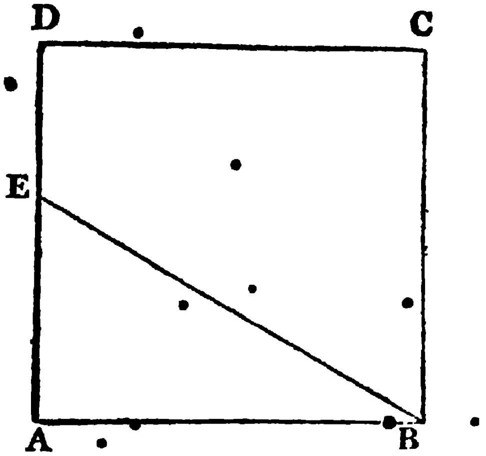
To part from a Square or Rectangle, any proposed Quantity of Land, either in a right-angled Triangle or Trapezoid, by a Line drawn from any of the Angles to either of the opposite Sides.

RULE.—When the proposed area is to be parted off in a triangle, divide double this area by the base or side upon which it is to be parted off, and the quotient will be the perpendicular.

When the proposed area is to be parted off in a trapezoid, subtract it from the area of the square or rectangle, and part off the remainder in a triangle, as above directed.

EXAMPLES.

1. From A B C D representing a square, whose side is 900 links, part off a triangle which shall contain 2A. 1R. 36P. by a line drawn from the angle B to the side A D.



2A. 1R. 36P. = 247500 square links.

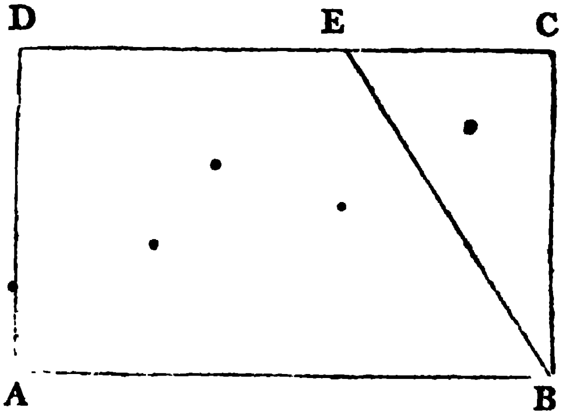
2

9,00|4950,00

550 links, the perpendicular A E.

Hence A B E is the triangle required.

2. From A B C D representing a rectangle, whose length is 1265, and breadth 758 links, part off a trapezoid which shall contain 7A. 3R. 24P., by a line drawn from the angle B to the side C D.



sq. links.

958870 the area of the rectangle.

790000 ditto of the trapezoid.

168870 difference, the area of the triangle.

2

758)337740(445.5 links, the perpendicular C E.

3032 Hence A B E D is the trapezoid required.

3454

3032

4220

3790

4300

3790

510

3. From a rectangular field, whose length is 1560, and breadth 1000 links, it is required to part off a trapezoid, which shall contain 12A. 3R. 12P., by a line drawn from any of the angles to the longer opposite side.

Ans. The area of the rectangle is 15A. 2R. 16P.; consequently, the area of the triangle is 2A. 3R. 4P., and its perpendicular 555 links.

PROBLEM XIII.

To part from a Triangle, upon the base or longest side, any proposed Quantity of Land, by a Line drawn from either of the Angles at the Base, to the opposite Side.

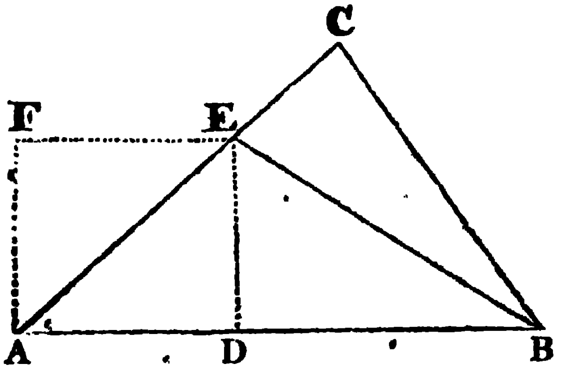
RULE.—Divide twice the proposed area by the base upon which it is to be parted off, and the quotient will be the perpendicular.

Or, if the proposed area be divided by half the base, the quotient will be the perpendicular.

Note.—A Parallel Ruler may be used with advantage in this, and several of the following Problems.

EXAMPLES.

1. From A B C representing a triangle, whose base A B is 1200, and sides A C and B C, 1000 and 800 links respectively, part off 2A. 2R. 24P. by a line drawn from the angle B to the side A C.



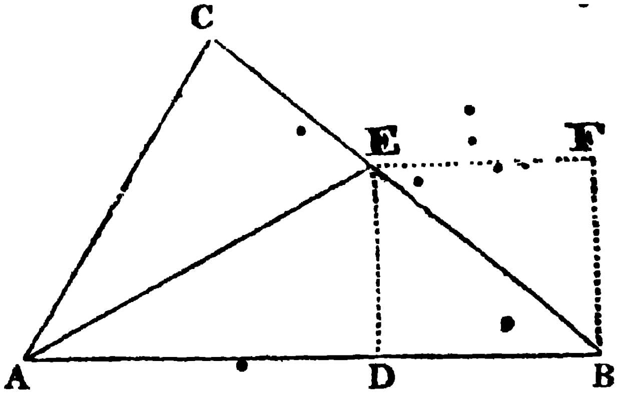
$$
\begin{array}{r}
2\text{A. } 2\text{R. } 24\text{P.} = 265000 \text{ square links.} \\
2 \\
\hline
12{,}00)\overline{5300{,}00} \\
\underline{\underline{441.6}} \text{ links, the perpendiculars D E.}
\end{array}
$$

At A, erect the perpendicular A F, which make = 441.6 links; then draw F E parallel to A B, and it will intersect the side A C, in the point to which the division-fence B E must be made.

Or, by the plotting-scale, erect the perpendicular D E = 441.6 links, which will determine the point E.

By the scale, you will find A E = 664 links; measure, therefore, in the field, 664 links from A to E; stake out the line B E, and A B E will be the triangle required.

2. From A B C representing a triangle, whose base A B is 1300, and sides B C and A C, 1100 and 900 links respectively, part off 1A. 3R. 36P. by a line drawn from the angle A to the side B C, so that the triangle A E C may contain the proposed quantity.



From the three sides, by Note 4, Part IV., the area of the given triangle is found = 488076 square links.

And, 1A. 3R. 36P. = 197500 square links.

The difference = 290576, the area of the triangle A B E.

```
                         2
              1300)581152(447 links, the perpendicular D E.
                   5200
                    6115
                    5200
                     9152
                     9100
                       52
```

By the mode described in the last example, determine the point E, which you will find at the distance of 658 links from the angle B; measure this distance in the field, from B to E, and proceed as before.

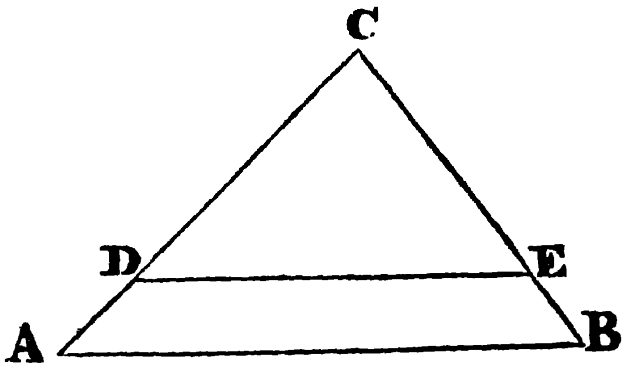
3. From a triangular field, whose sides are 1500, 1200, and 1000 links respectively, part off 3A. 2R. 16P. by a fence made from the greater angle at the base, to the opposite side.

Ans. The perpendicular of the triangle required, is found to be 480 links; and it rises upon the base, at the distance of 537 links from the less angle.

PROBLEM XIV.

To part from a Triangle, any proposed Quantity of Land, by a Line parallel to any one of its Sides.

Rule.—The areas of similar triangles are to one another in the duplicate ratio of their homologous sides: hence, as the area of the triangle A B C is to the square of the side A C, or B C, so is the area of the triangle D E C to the square of the side D C, or E C respectively. (See Theo. 13, Part I.)



EXAMPLES.

1. Suppose the base A B = 1200, the side A C = 1000, and the side B C = 800 links; part off 1A. 2R. 16P. by the line D E parallel to A B.

From the three sides, by Note 4, Part IV., we find the area of the triangle.

A B C = 396863 square links.

And, 1A. 2R. 16P. = 160000 square links.

The difference = 236863, the area of the triangle D E C.

Then, as 396863 : 1000 × 1000 :: 236863 : 596838.20; and $\sqrt{596838.20}$ = 772.5 links = D C; hence 1000 − 772.5 = 227.5 links = A D. Again, as 396863 : 800×800 :: 236863 : 381976.45; and $\sqrt{381976.45}$ = 618 links = E C; then 800 − 618 = 182 links = B E.

Measure, therefore, in the field, 227.5 links from A to D; and from B to E measure 182 links; stake out the line D E, and the work will be completed.

2. From a triangular field, whose sides are 1800, 1500, and 1200 links respectively, part off 3A. 2R. 32P. by a line parallel to the shortest side.

Ans. The area of the given triangle is 892941 square links; the area of the triangle made by the line of division is 522941 square links; and one of its sides, from the angle opposite the line of division, to the commencement of that line, is 1147.9, and the other 1377.4 links.

PROBLEM XV.

To part from a Rectangle or Triangle, any proposed Quantity of Land, upon a Line on which there are Offsets, when the Area of those Offsets is to be considered as Part of the Portion to be parted off.

Rule.—Find the area of the offsets, which subtract from the portion to be parted off, and then proceed with the remainder, as directed in the preceding problems.

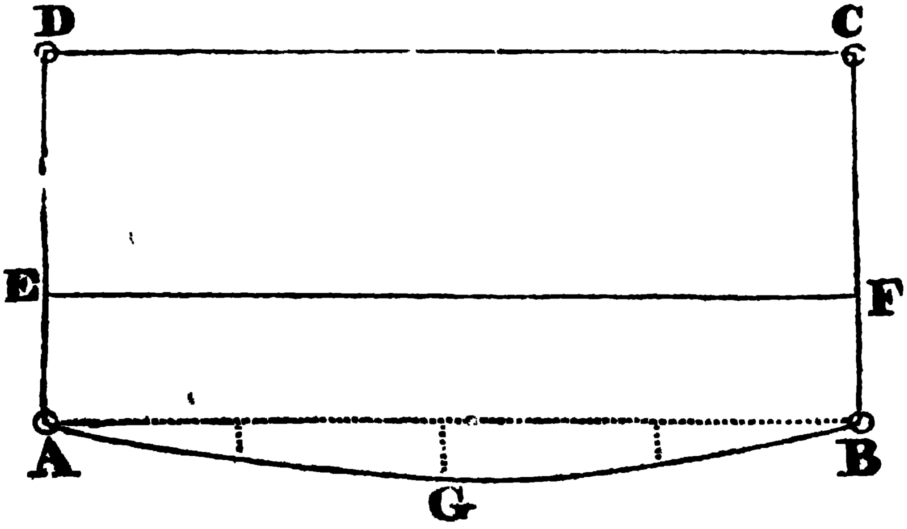
But, in a rectangle, when there are offsets on one, or both of the lines adjoining that upon which the given quantity is to be parted off, reject these offsets, and proceed as before directed.

Then, having found the distance at which the line of division must be from that upon which the given quantity is to be parted off; find the area of the offsets contained between those lines, which area divide by the latter line; and the quotient will be the distance by which the former line must be approximated to the latter.

EXAMPLES.

1. From a rectangular field, whose dimensions are contained in the following notes, part off 2A. 3R. 32P. upon the chain-line A B, so that the offsets taken upon that line may be included.

	D A	
	560	
	L. off D.	
	C D	
	1200	
	1000	
	L. off C.	
	B C	
	560	
	L. off B.	
	A B	
	1200	0
	1000	
	900	60
	600	80
	300	50
	000	0
Begin	at A.	Range E.

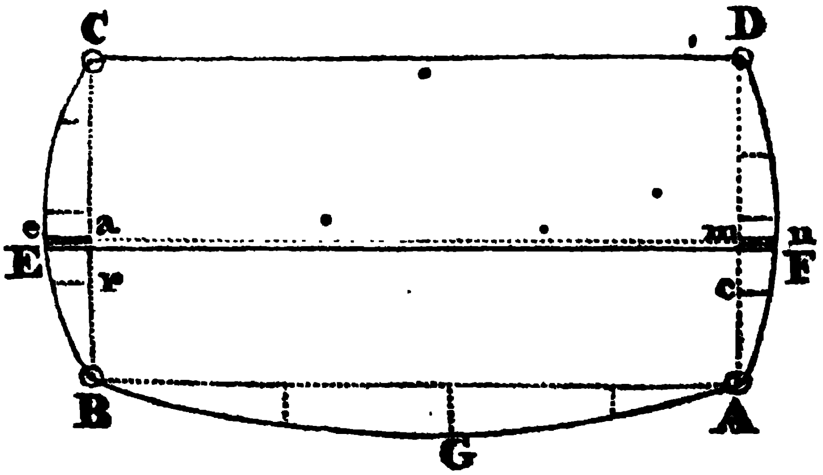


sq. links.
2A. 3R. 32P. = 295000
57000 the area of the offsets.
12,00|2380,00 the difference.
198.4 links = A E, or B F.

Hence, the irregular figure A G B F E, contains 2A. 3R. 32P.

2. From a rectangular field, whose dimensions are contained in the following notes, part off 2A. 2R. 8P. by a line parallel to the chain-line A B; so that the offsets taken upon this line, and also those upon the two adjoining lines, contained between the chain-line A B and the line of division, may be included.

	D A	
0	500	
40	350	
55	250	
45	150	
0	000	
	R. off D.	
	C D	
	1000	
	R. off C.	
	B C	
0	500	
40	400	
60	250	
45	150	
0	000	
	R. off B.	
	A B	
0	1000	
50	700	
70	450	
40	200	
0	000	
Begin	at A.	Range W.



sq. links.

2A. 2R. 8P. = 255000

40250 the area of the offsets taken on A B.

1,000|214,750 the difference.

214.750 links = B a or A m, which we may call 215 links. Now 215 − 150 = 65 = r a = c m; and, by the scale, a e is found to measure 58, and m n, 53 links; hence the area of the offset B a e + the area of the offset A m n = 13282, which divided by 1000, gives 13 links, the distance by which the line e n must be approximated to A B. Consequently, E F is the true line of division; and the irregular figure A G B E F contains 2A. 2R. 8P. minus the two shaded offsets.

PROBLEM XVI.

To part from a Trapezium, or any irregular Polygon whatever, any proposed Quantity of Land, by a Line draw parallel to any of the Sides, or by a Line drawn from any of the Angles, or from any assigned Point in one of the Sides, to any of the opposite Sides.

Rule 1.—Having laid down the whole figure, draw a guess-line in the direction required, parting off, as nearly as can be judged, the proposed quantity; after which, by the scale, measure, with the greatest accuracy, the guess-line, and also the quantity thus parted off.

Then, if the guess-line or line of division be drawn from an angle, or from any assigned point in a side, divide the difference between the proposed quantity and the quantity parted off, by half the guess-line, and the quotient will be the perpendicular to be set off, on one side, or the other, of the guess-line, accordingly as the quantity parted off is more or less than the quantity proposed. To the end of this perpendicular, from the point assigned, draw a new line of division; and it will part off the quantity required.

2. But if the guess-line be drawn parallel to any of the sides, divide the difference before mentioned, by the whole guess-line,

and the quotient will be the perpendicular to be set off from each end of the guess-line, on one side, or the other, as above.

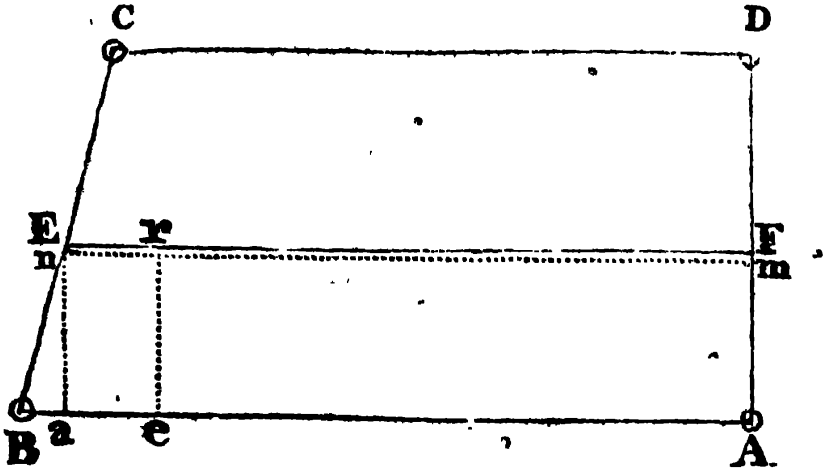
Note 1.—When from a trapezium, approaching very nearly to a rectangle, it is required to part off any number of acres, &c. by a line parallel to one of its sides; it may be done as directed in Prob. XI.; and if there be offsets upon any of the lines, they must be treated as in the last Problem.

2.—In using guess-lines, it is not necessary that the learner should draw them so as to coincide in measure, with those of the examples which he is performing. It will be sufficient for him to proceed in a similar manner.

EXAMPLES.

1. From a trapezium, whose dimensions are contained in the following notes, part off 2A. 2R. 24P. by a line parallel to the side A B.

Return	B D 1249 1000 to B.	Diag.
	A C 1112 1000 R. off A.	Diag.
	D A 550 R. off D.	
	C D 979 R. off C.	
	B C 557 R. off B.	
Begin	A B 1114 1000 at A.	Range W.



Having laid down the figure, draw the guess-line m n parallel to A B; and from n, let fall the perpendicular a n; then, suppose m n = 1058 links, a n will be = 230, and A a = 1052 links; therefore, B a = 1114 − 1052 = 62 links.

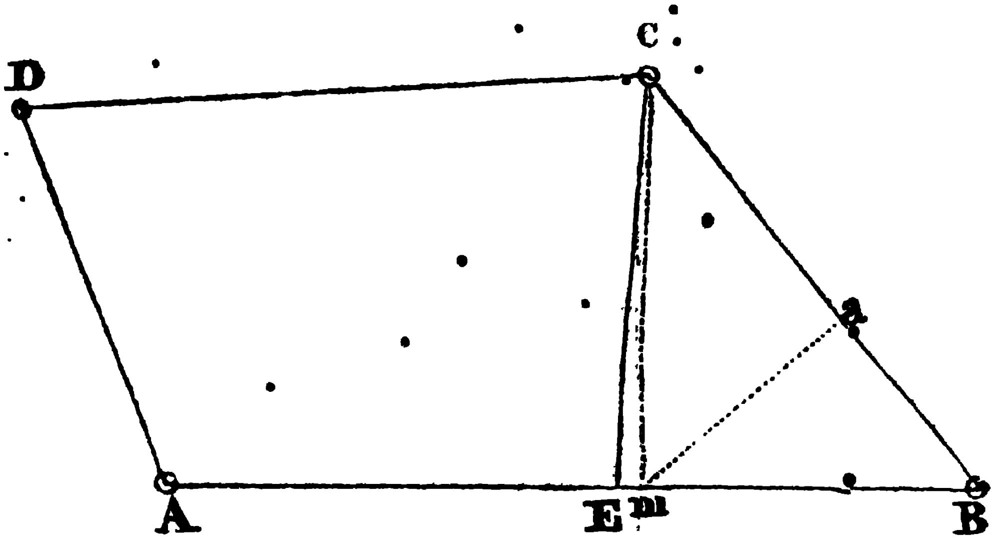
sq. links.
Then, 1055 × 230 = 242650 the area of the trapezoid A a n m.
And, 230 × 31 = 7130 the area of the triangle B a n.
The sum - - = 249780 the area of the trapezium A B n m.
2A. 2R. 24P. = 265000
15220 the difference between the quantity proposed, and the quantity parted off by the guess-line; which, divided by 1058, gives 14.4 links, to be set off perpendicularly from m and n toward D and C. Hence, E F is the true line of division; and the trapezium A B E F contains 2A. 2R. 24P.

As A is very nearly a right-angle, measure, in the field, 230 + 14.4 = 244.4 links, from A to F. Then, upon any part of the line A B, (toward B) as at e, erect the perpendicular e r, which make = 244.4 links; stake out the line E r F, and the work will be completed.

2. From a trapezium, whose dimensions are contained in the following notes, part off, in a triangle, 1A. 3R. 12P. by a line drawn from the angle C to the side A B.

	B D	
	1634	Diag.
	1000	
Return	to B.	

	A C 1010 L. off A.	Diag.
	D A 620 L. off D.	
	C D 1010 L. off C.	
	B C 820 L. off B.	
Begin	A B 1300 1000 at A.	Range E.



Having laid down the figure, draw the guess-line C m, which suppose = 638 links. From m let fall the perpendicular m a, which will be = 417 links.

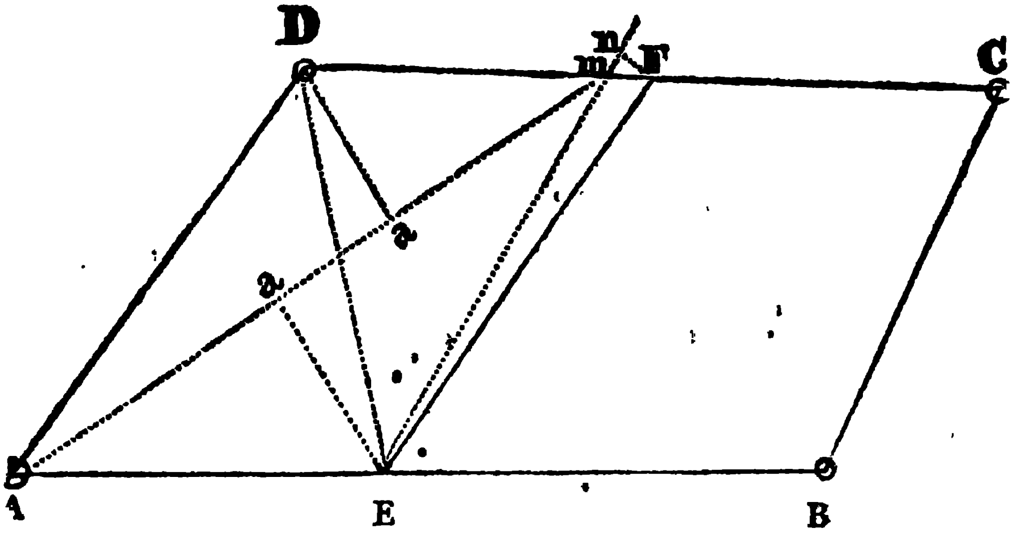
sq. links.
Then, 410 × 417 = 170970 the area of the triangle B C m.
1A. 3R. 12P. = 182500
11530 the difference between the quantity proposed, and the quantity parted off by the guess-line, which is divided by 319 (half the guess-line) gives 36 links, to be set off from m toward A. Hence, E C is the true line of division; and the triangle B C E contains 1A. 3R. 12P.

Also, A E is found = 731 links; measure, therefore, in the field 731 links from A to E; stake out the line E C, and the work will be completed.

Note.—The Rules given in this problem, for parting off land from irregular figures, are generally adopted by Practical Surveyors; because they may be applied to any irregular figure whatever. Land, however, may sometimes be parted off more directly: for instance, the foregoing example may be performed by the mode followed in Prob. XIII., i. e. if the given quantity, in square links, be divided by half the line B C, the quotient will be the perpendicular of the triangle B C E; then, at the distance of this perpendicular, a line drawn parallel to B C, will intersect the line A B in E, the point to which the division-fence must be made.

3. From a field, whose dimensions are contained in the following notes, part off 3A. 2R. 16P. toward A D, by a fence made from the side A B to the side C D, so that the fence may commence at the distance of 600 links from A.

Return	B D 1050 to B.	Diag.
	AC 1708 1000 L. off A.	Diag.
	D A 790 L. off D.	
	C D 1130 1000 L. off C.	
	B C 640 L off B.	
Begin	A B 1320 1000 at A.	Range E.



Having constructed the figure, set off 600 links from A to E, and draw the guess-line E m, which suppose = 702 links; the diagonal A m will be = 1132, the perpendicular D a = 278, and the perpendicular E a = 318 links. Hence, the area of the trapezium A D m E, is found = 337336 square links; but the quantity proposed (360000 square links) exceeds the quantity parted off by 22664 square links: this divided by 351 (half the guess-line) gives 64.5 links, to be set off from the line E m, perpendicularly toward B C.

Now, continue the line E m, and upon it erect the perpendicular n F = 64.5 links. The line F E will be the true line of division; and the trapezium A D F E contains 3A. 2R. 16P.

If it had been required to set off the perpendicular on the other side of the line E m, you must still have erected it so that its end might have touched the line C D.

Now, by the scale, D F is found = 553 links. Measure, therefore, in the field, 600 links from A to E, and 553 from D to F; stake out the line F E, and the work will be completed.

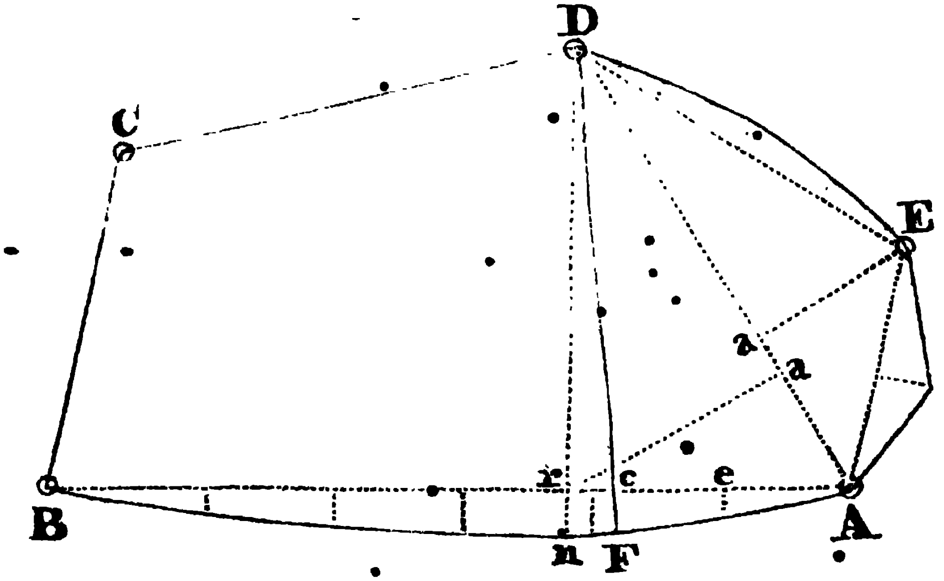
Note.—The last example may also be performed by finding the area of the triangle A D E, and subtracting it from the given quantity; then, if the remainder be divided by half the line D E, the quotient will be the perpendicular of the triangle D E F.

At the distance of this perpendicular, draw a line parallel to D E; and it will intersect the line C D in F, the point to which the division-fence must be made.

4. From an irregular field, whose dimensions are contained in the following notes, part off 2A. 3R. 20P. toward the line A E, by a fence made from the angle D to the side A B.

	E B	
	1398	Diag.
	1000	
	R. off E.	
	C E	
	1240	Diag.
	1000	
	500	m, proof-line, goes to D, and measures 324.
	R. off C.	
	A C	
	1260	Diag.
	1000	
	R. off A.	
	E A	
0	400	
80	200	
0	000	
	R. off E.	
	D E	
0	600	
25	450	
35	300	
20	150	
0	000	
	R. off D.	
	C D	
	740	
	R. off C.	
	B C	
	550	
	R. off B.	

	A B	
0	1250	
35	1000	
50	800	
60	600	
50	400	
30	200	
0	000	
Begin	at A.	Range W.



Having laid down the figure, draw the guess-line D n, which suppose = 766 links; then the diagonal A D will be = 824, the perpendicular E a = 278, and the perpendicular r a = 372 links; r e also will be = 228, and r n = 52 links.

sq. links.
267800 the area of the trapezium A r D E.
12000 } D E { the area of the offsets taken
16000 } E A { on the different lines.
12348 } A r {

308148 the area of the irregular figure A n D E.
2A. 3R. 20P. = 287500

20648 the difference between the quantity proposed, and the quantity parted off by the guess-line, which divided by 383 (half the guess-line) gives 54 links, to be set off from n toward A. Hence, D F is the true line of division; and the irregular figure A F D E contains 2A. 3R. 20P.

Now, by the scale, A c is found = 377 links. Measure, therefore, in the field, 377 links from A to c ; stake out the line D c F, and the work will be completed.

Note 1.—If the area of the irregular figure A D E, be subtracted from the given quantity, and the remainder divided by half the line A D ; the quotient will be the perpendicular of the triangle A D F ; the side A B being nearly straight from A to F.

Now, at the distance of this perpendicular, draw a line parallel to A D ; and it will intersect the side A B in F, the point to which the division-fence must be made.

2.—It is not absolutely necessary to survey and plan a whole field, in order to part a portion from it, as the guess-line and portion parted off may be measured in the field ; but, in my opinion, the former, *in general*, is a more eligible method than the latter ; as you have a better opportunity of proving your work.

SECTION II.

THE METHOD OF DIVIDING A PIECE OF LAND AMONG SUNDRY CLAIMANTS, IN THE PROPORTION OF THEIR RESPECTIVE CLAIMS, OR A COMMON, &c. OF VARIABLE VALUE, AMONG ANY NUMBER OF PROPRIETORS, IN THE PROPORTION OF THEIR RESPECTIVE INTERESTS.

WHEN land becomes the property of coheirs, copartners, joint purchasers, &c. it is generally divided into such shares, as the coparties are entitled to ; and this cannot possibly be accurately effected without the assistance of some person, who is not only well acquainted with surveying, but also with the method of dividing land.

In this process an error is evidently much more material than one committed in surveying.—When a field, &c. is to be divided into any number of parts, equal or unequal, it is necessary, first, to ascertain its dimensions ; and next to inquire of the parties concerned, in what part of the property in question, they wish their respective shares to lie.

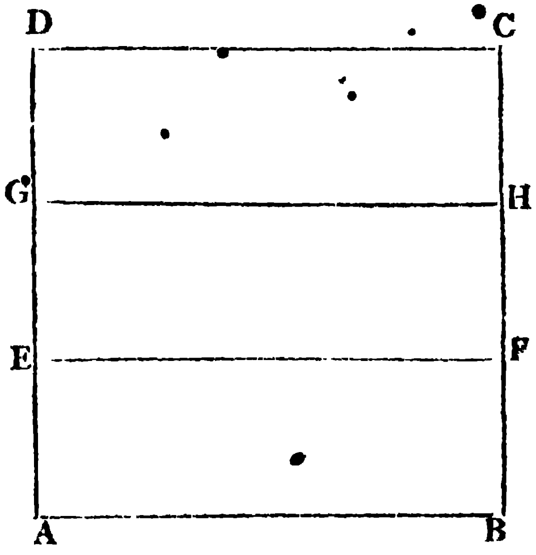
PROBLEM I.

To divide a Square or Rectangle, either equally or unequally, among any Number of Persons, by Lines parallel to one of its Sides.

Rule.—If the parts, into which the field is required to be divided, be equal, divide the side which will be cut by the division-fences, by the number of those parts, and the quotient will be the distance at which the division-fences must be placed from each other, and from the outsides to which they are parallel. But, if the parts be unequal, you must then part off each person's share as directed in Sect. I. Prob. XI.

EXAMPLES.

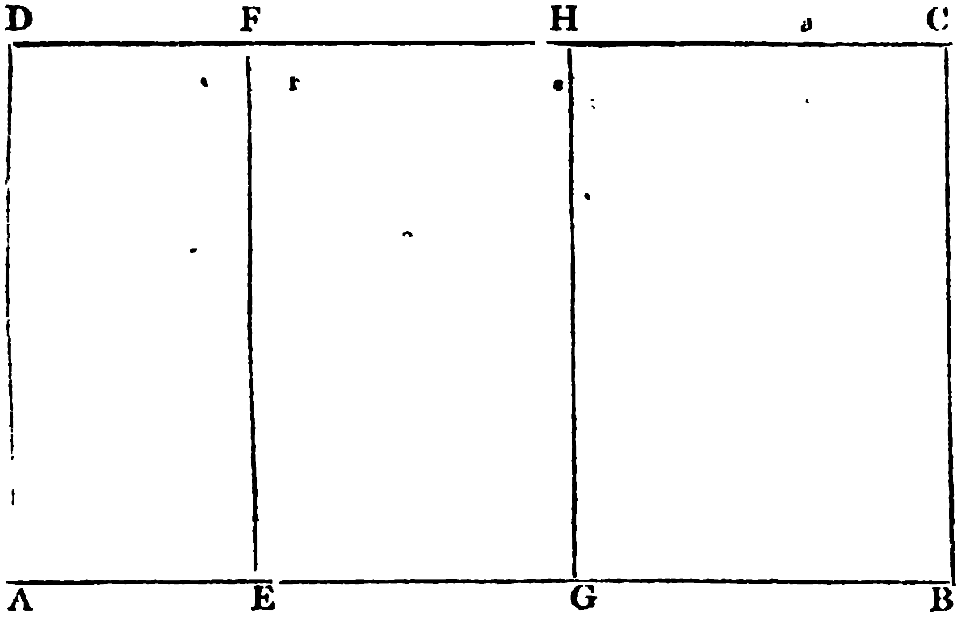
1. Divide the square A B C D containing 5a. 2r. 20p. into three equal parts, by fences parallel to the side A B.



Here 5a. 2r. 20p. = 562500 square links; and $\sqrt{562500} =$ 750 links, the side of the square. This divided by 3, the number of parts, gives 250 links, the distance at which the first division-fence must be placed from A B, &c. From A and B, therefore, set off 250 links to E and F; join E F, and the rectangle A B F E, will be one of the parts required.

Again, from E and F set off 250 links to G and H; join G H, and the rectangles E F G H, and G H C D will be the two other parts required.

2. Divide A B C D representing a rectangular field, whose length is 1500, and breadth 800 links, among three men, A, B, and C, by fences parallel to the side A D, so that A may have 3A. B 4A. and C the remainder.



Here 3A. = 300000 square links, which divided by 800, gives 375 links = A E or D F: hence the rectangle A E F D contains A's share.

Again, 4A. = 400000 square links, which divided by 800, gives 500 links = E G or F H: hence the rectangle E G H F contains B's share.

Now, the rectangle A B C D, is found to contain 12A.; consequently, the rectangle G B C H containing 5A. is C's share.

Note.—This and similar examples may also be performed by the following proportion: As the area of the whole rectangle is to the whole base, or side cut by the division-fences, so is each person's share of the rectangle to his share of the base.

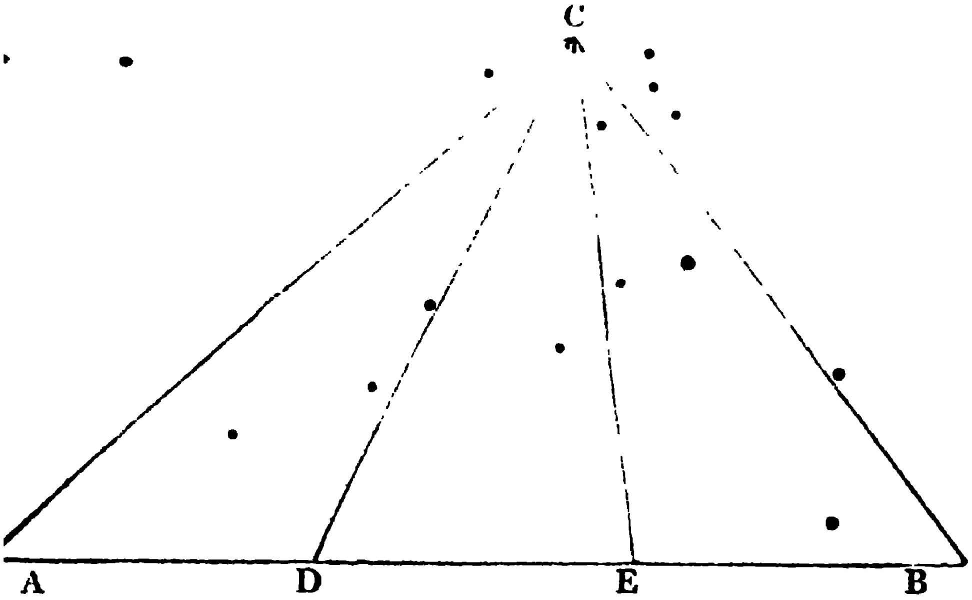
PROBLEM II.

To divide a triangular Field, either equally or unequally, among any Number of Persons, by Fences made from any of its Angles to the opposite Side.

Rule.—If the parts, into which the field is required to be divided, be equal, divide the base, or side to which the division-fences are to be made, by the number of those parts, and the quotient will be each person's share of the base. But, if the parts be unequal, say, as the area of the whole triangle is to the whole base, so is each person's share of the triangle to his share of the base. (See Simpson's Geom. IV. 7.; Reynard's Geom. V. 1.; and Euclid VI. 1.)

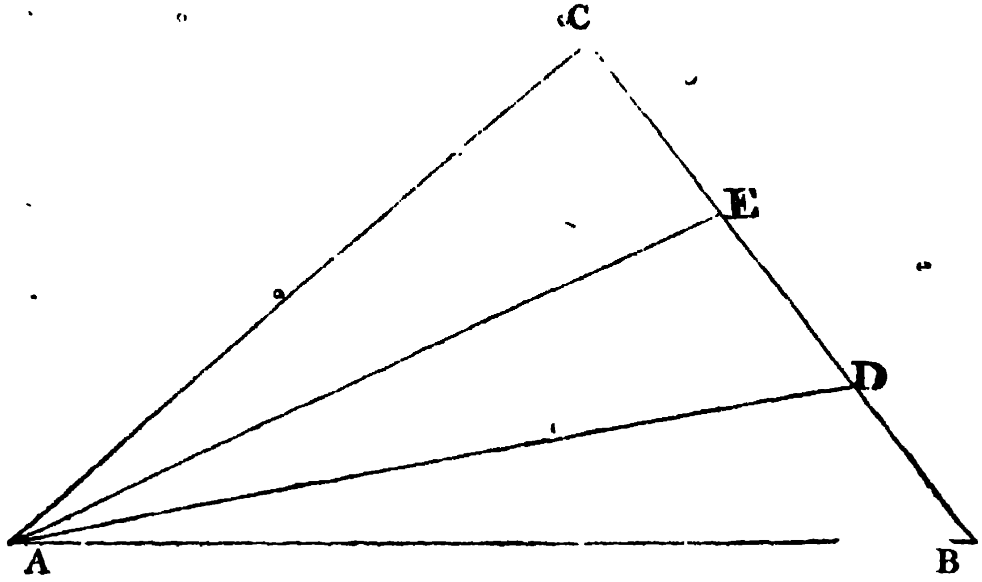
EXAMPLES.

1. Divide A B C, representing a triangular field, whose sides A B, A C, and B C are 1500, 1200, and 1000 links respectively, into three equal parts, by fences made from the angle C to the side A B.



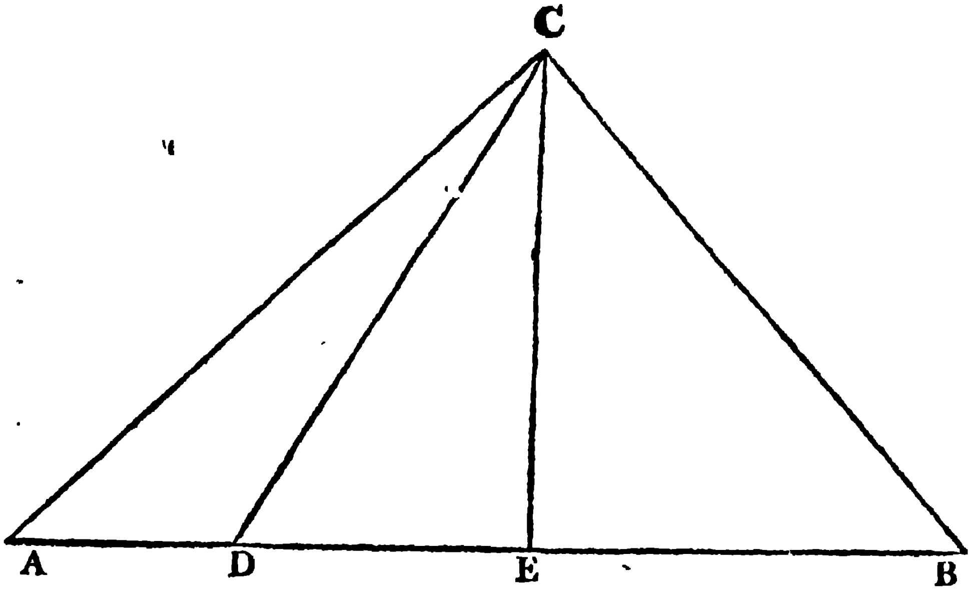
Here A B = 1500 links, which divided by 3 (the number of parts) gives 500 links, each person's share of the base. From A, therefore, set off 500 links to D, and from D 500 links to E; draw the lines C D and C E, to represent the division-fences; and the triangles A D C, D E C, and E B C, are the three equal parts required.

2. Divide A B C, representing a triangular field, whose sides A B, A C, and B C are 1450, 1150, and 960 links respectively, into three equal parts, by fences made from the angle A to the side B C.



Here B C = 960 links, which divided by 3 (the number of parts) gives 320 links, each person's share of the side B C. From B, therefore, set off 320 links to D, and from D set off the same distance to E; and the lines A D and A E will be the lines of division required.

3. Divide A B C, representing a triangular field, whose sides A B, A C, and B C are 2200, 1700, and 1500 links respectively, among three persons A, B, and C; so that, each person partaking of a pond at C, A may have 3A. B 4A. and C the remainder.



Having the three sides of the triangle, we find its area = 1272792.2 square links; then, as 1272792.2 : A B = 2200 :: A's share = 300000 square links : 518.5 links, A's share of the base.

Again, as 1272792.2 : 2200 :: 400000 : 691.3 links, B's share of the base.

The remainder of the base, which is 990.2 links, belongs to C; and, deducting 7A., the sum of A and B's shares, from the area of the whole triangle, we find remaining for C's share 572792.2 square links = 5A. 2R. 36P.

From A, therefore, set off 518.5 links to D, and from D set off 691.3 links to E; and the lines C D and C E will be the lines of division required.

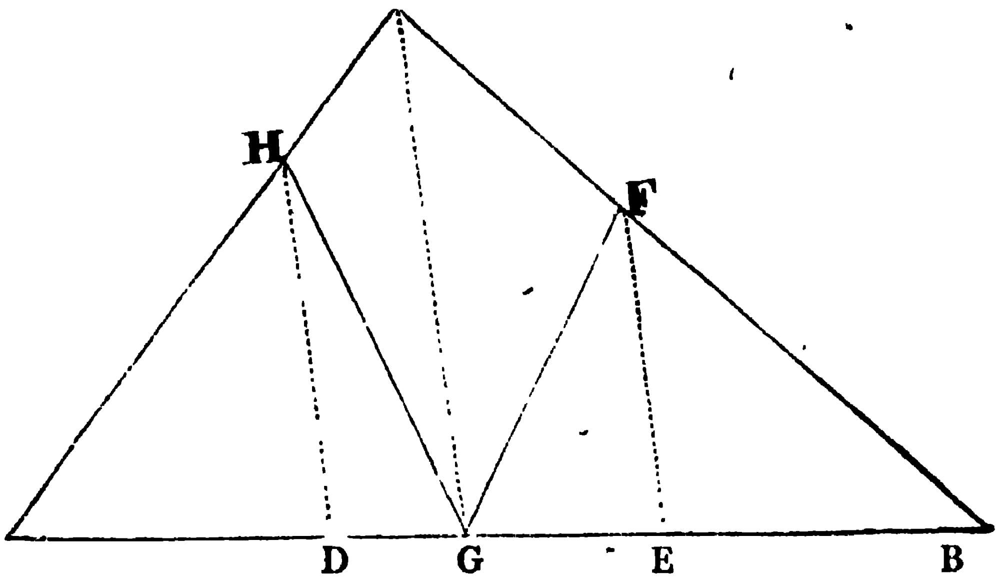
PROBLEM III.

To divide a triangular Field, either equally or unequally, among any Number of Persons, by Fences proceeding from any assigned Point in one of its Sides.

RULE.—Divide the base or side of the triangle from which the division-fences are to be run, as directed in the last problem. From the assigned point, draw a line to the opposite angle; and parallel to this line, draw a line from each point of division on the base, until it intersects the opposite side. From these points of intersection draw lines to the point assigned; and they will be the lines of division required. (See Dr. Hutton's Course of Mathematics, Vol. III. Chap. 7, Prob. 2.)

EXAMPLES.

1. Divide A B C, representing a triangular field, whose sides A B, B C, and A C are 1500, 1150, and 950 links respectively, equally among three persons, by fences proceeding from a gate, 700 links distant from A on the base, leading into a lane, through which alone a road can be had to the field.

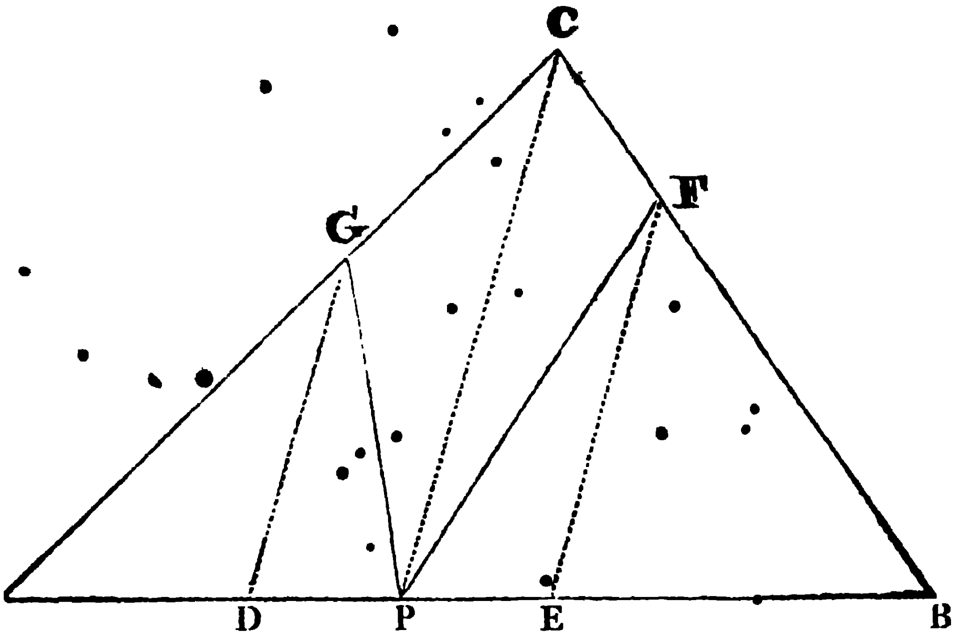


By the question A B = 1500 links, divided by 3, gives 500 links, each person's share of the base. From A, therefore, set off 500 links to D, and from D set off the same extent to E. Then from the gate G draw the line G C; and, parallel to it, the lines D H and E F. From H and F draw the lines H G and F G, and they will be the fences of division required.

Now, by similar triangles, (Theo. 11. Part I.) as A G : A C : : A D : A H = 678.5 links; and, as B G : B C : : B E : B F = 718.7 links. Measure, therefore, in the field, 678.5 links from A to H, and 718.7 from B to F; stake out the lines H G and F G, and the work will be completed.

Note.—After the points H and F have been determined, by the parallel ruler, the lines A H and B F may be measured by the scale.

2. Divide A B C, representing a triangular field, whose sides A B, A C, and B C are 1400, 1200, and 1000 links respectively, among three persons, A, B, and C, by fences proceeding from a pond which is at the distance of 600 links from A on the base; so that each person partaking of the pond, A may have 1 acre, 2 roods, and 16 perches; B 1 acre, 3 roods, and 20 perches; and C the remainder.



Having the three sides of the triangle, we find its area = 587877.5 square links. Then, as 587877.5 : A B = 1400 :: A's share = 156250 square links : 372 links, his share of the base.

Again, as 587877.5 : 1400 :: 187500 : 446.5 links, B's share of the base.

From A, therefore, set off 372 links to D, and from D set off 446.5 to E. Then from the pond P draw the line P C, and parallel to it, the lines D G and E F. From G and F draw the lines G P and F P; and the triangle A P G will contain A's share; the trapezium P G C F, B's share; and the triangle B P F, C's share = 244127.5 square links = 2 acres, 1 rood, and 30 perches.

By similar triangles, we find A G = 744, and B F = 726.8 links: proceed, therefore, in the field, as directed in the last example.

PROBLEM IV.

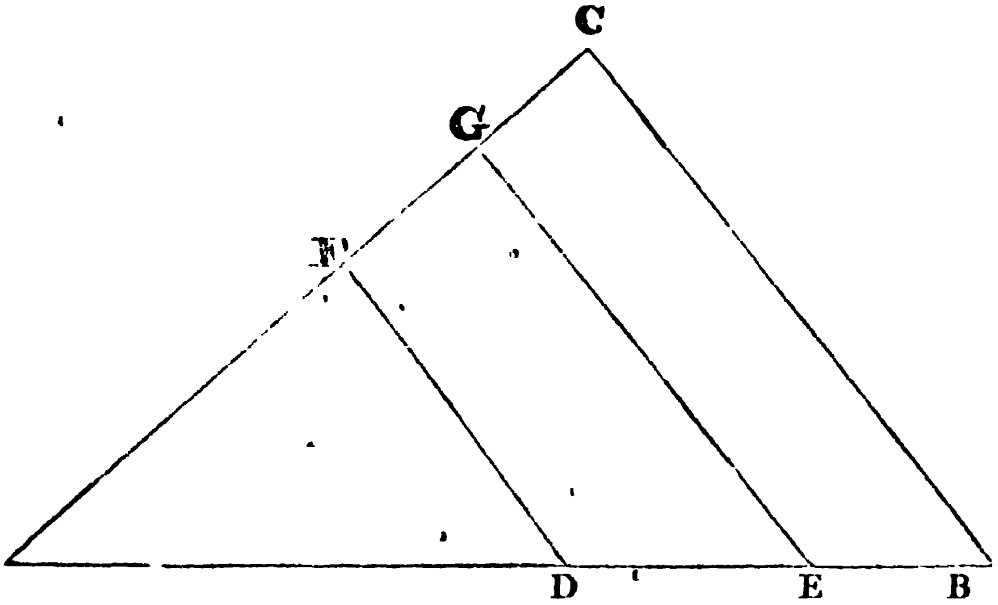
To divide a triangular Field, either equally or unequally, among any Number of Persons, by Fences made parallel to one of its Sides.

Rule.—By the rule given in Sect. I. Prob. 14, part off the first person's share; proceed with the remainder of the triangle.

and the next person's share in the same manner; and thus continue, till the whole triangle is divided.

EXAMPLES.

1. Divide A B C, representing a triangular field, whose sides A B, A C, and B C are 1500, 1200, and 1000 links respectively, into three equal parts, by fences made parallel to the side B C.



The area of the given triangle is found = 598116.9 square links, which divided by 3, gives 199372.3 square links for each person's share; consequently, 398744.6 square links, is the area of the triangle A E G.

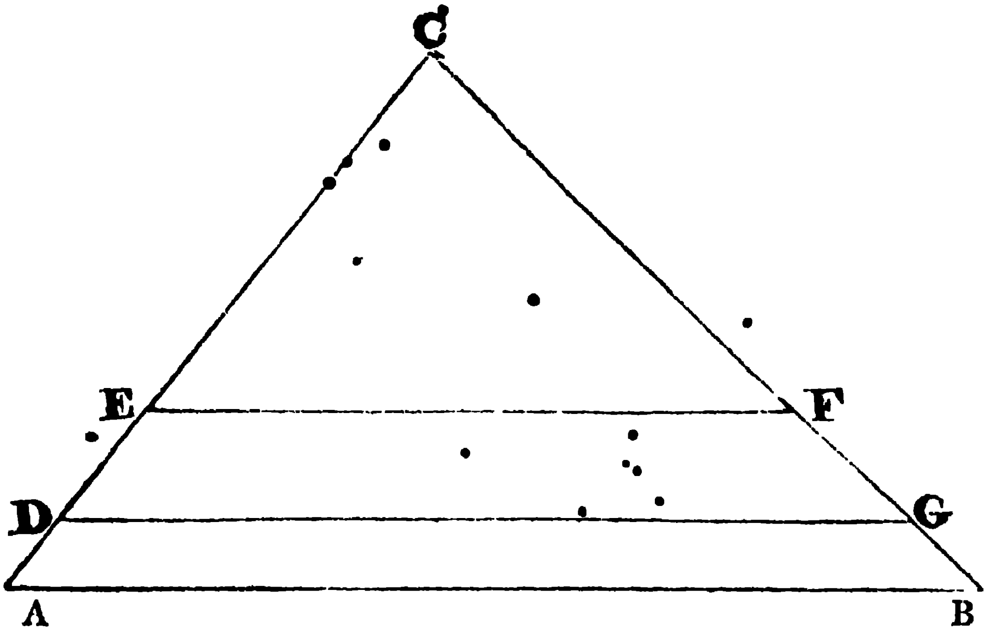
Then, as 598116.9 : 1500 × 1500 :: 398744.6 : 1500000; and $\sqrt{1500000} = 1224.7$ links = A E.

And, as 598116.9 : 1200 × 1200 :: 398744.6 : 960000; and $\sqrt{960000} = 979.8$ links = A G.

Again, as 398744.6 : 1224.7 × 1224.7 :: 199372.3 : 749945.04; and $\sqrt{749945.04} = 865.9$ links = A D.

And, as 398744.6 : 979.8 × 979.8 :: 199372.3 : 480004.02; and $\sqrt{480004.02} = 692.8$ links = A F. Hence, the triangle A B C is divided into three equal parts, as required.

2. Divide A B C, representing a triangular field, whose sides A B, B C, and A C are 2200, 1700, and 1500 links respectively, among three persons, A, B, and C, by fences made parallel to the base A B, so that A may have 3A. B 4A. and C the remainder.



The area of the triangle A B C is found = 1272792.2 square links, from which taking 300000 square links, (= A's share) we leave 972792.2 square links, the area of the triangle D G C. From this taking 400000 square links, (= B's share,) we leave 572792.2 square links, the area of the triangle E F C = 5A. 2R. 36P. = C's share.

Then, as 1272792.2 : 1700 × 1700 :: 972792.2 : 2208820.46; and $\sqrt{2208820.46}$ = 1486.2 links = C G.

And, as 1272792.2 : 1500 × 1500 :: 972792.2 : 1719669.91; and $\sqrt{1719669.91}$ = 1311.3 links = C D.

Again, as 972792.2 : 1486.2 × 1486.2 :: 572792.2 : 1300563.40; and $\sqrt{1300563.40}$ = 1140.4 links = C F.

And, as 972792.2 : 1311.3 × 1311.3 :: 572792.2 : 1012467.60; and $\sqrt{1012467.60}$ = 1006.2 links = C E. Hence, the triangle A B C is divided into three parts, as required.

PROBLEM V.

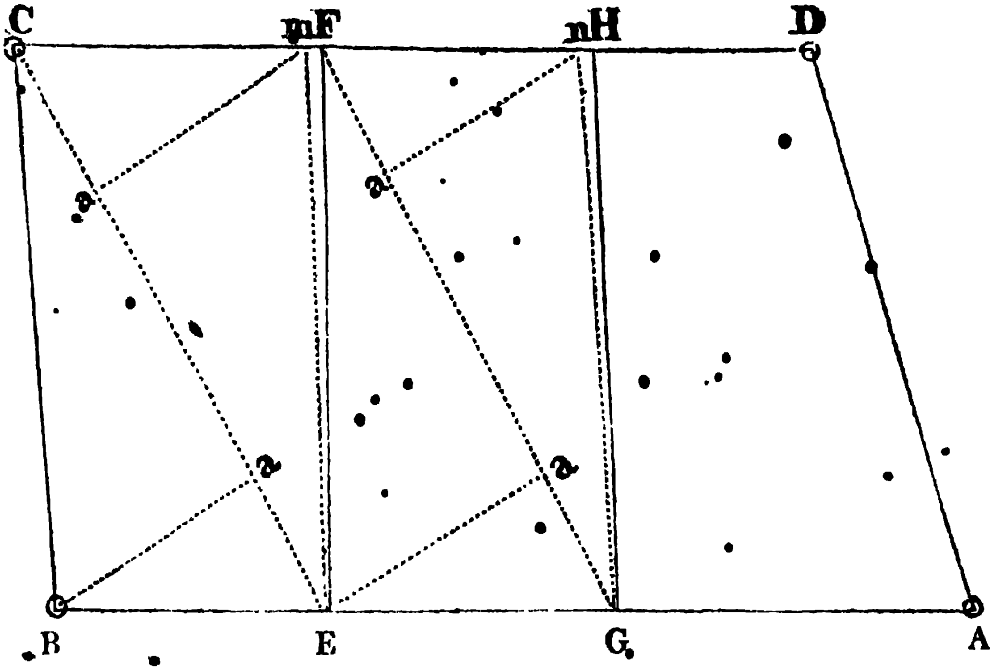
To divide a Trapezium, or an irregular Polygon, equally or unequally, among any number of Persons, by Fences made in a given Direction.

Rule.—By the Rules given in Sect. I. Prob. 16, part off the first person's share; proceed with the remainder of the figure and the second person's share in the same manner; and thus continue, till the whole figure is divided.

EXAMPLES.

1. Divide a trapezium, whose dimensions are contained in the following notes, into three equal parts, by fences made from the side A B to the side C D.

	B D	
	1542	Diag.
	1000	
	Return to B.	
	A C	
	1848	Diag.
	1000	
	R. off A.	
	D A	
	915	
	R. off D.	
	C D	
	1347	
	1000	
	R. off C.	
	B C	
	885	
	R. off B.	
	A B	
	1547	
	1000	
Begin at	A. Range	W.



The area of the triangle A B C, is found = 681942, and the area of the triangle C D A = 585949 square links; consequently, the area of the trapezium A B C D = 1267891 square links, which divided by 3, gives 422630 square links, for each person's share.

Now, draw the guess-line E m, which suppose = 880 links; then the diagonal E C will be found = 1028, the perpendicular B a = 387, and the perpendicular m a = 424 links: hence, the area of the trapezium B C m E, is found = 416854 square links, which is too little by 5776 square links. This divided by 440 (half the guess-line) gives 13 links, to be set off from m toward D; consequently, E F is the true line of division.

Again, draw the guess-line G n, which suppose = 878 links; then will the diagonal G F = 1017, the perpendicular E a = 430, and the perpendicular n a = 385: hence, the area of the trapezium E F n G, is found = 414427 square links, which is too little by 3203 square links. This divided by 439 (half the guess-line) gives 19 links, to be set off from n toward D; consequently, G H is the true line of division; and the trapezium A B C D is divided into three equal parts, as required.

Now, by the scale, we find B E = 450, E G = 500, C F = 508, and F H = 468 links, which distances must be measured in the field, in order to determine the situations of the division-fences.

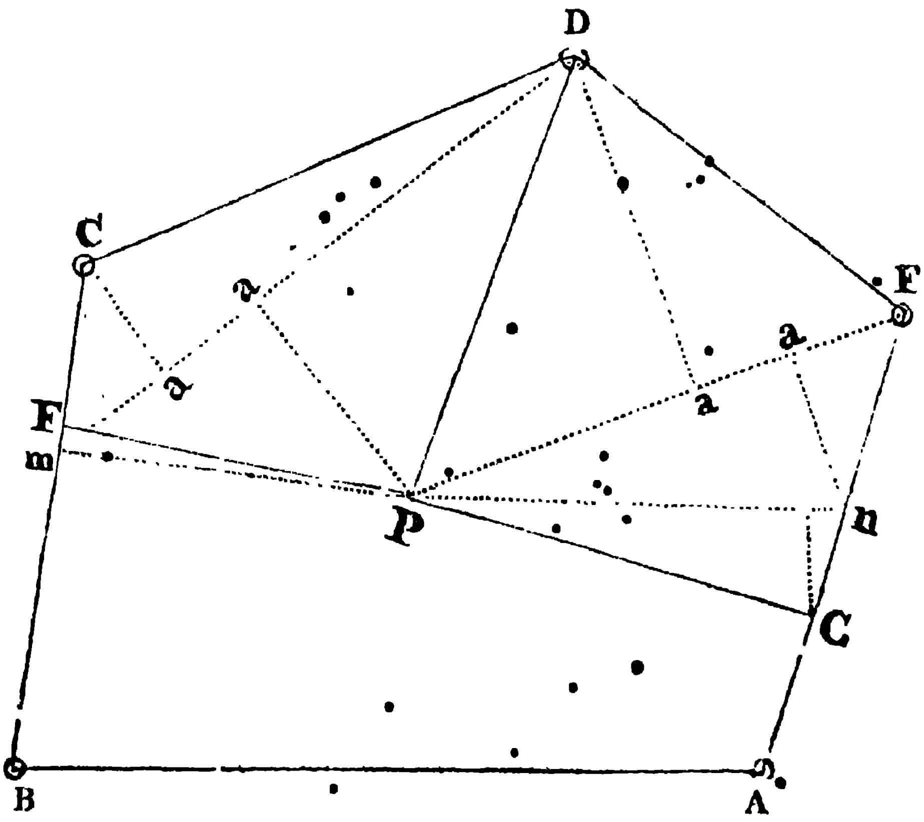
Note.—If we subtract the area of the triangle B C E, from the quantity to which each person is entitled, and divide the remainder by half the line C E, the quotient will be the perpendicular of the triangle C E F. By drawing a line parallel to C E, at the distance of this perpendicular, the point F may be determined.

In a similar manner, may be parted off the trapezium E F H G.

2. Divide a field, whose dimensions are contained in the following notes, among three persons, A, B, and C, so that each partaking of a pond at P, A may have 3A. B 4A. and C the remainder.

B D	
1447	Diag.
1000	
R. off B.	
E P	
1603	Diag.
1000	
R. off E.	
C E	
1300	Diag.
1000	
R. off C.	
A C	
1320	Diag.
1000	
700	Pond.
R. off A.	
E A	
750	
R. off E.	
D E	
650	
R. off D.	
C D	
850	
R. off C.	
B C	
800	
R. off B.	

A B
1200
.1000
Begin at A. Range W.



From the pond P, draw the line P D, and also the guess-line P m, which suppose = 558 links; then will the diagonal D m be = 1025, the perpendicular P a = 400, and C a = 195 links: hence, the area of the trapezium P m C D is found = 304937 square links, which exceeds A's share by 4937 square links. This divided by 279 (half the guess-line) gives 17.7 links, to be set off from m toward C; consequently, P F is the true line of division, and the trapezium P F C D contains A's share.

Again, draw the guess-line P n, which suppose = 696 links; then, the diagonal P E will be = 848, the perpendicular n a = 247, and D a = 552 links: hence, the area of the trapezium P n E D, is found = 338776 square links, which is less than B's share, by 61224 square links. This divided by 348 (half the guess-line) gives 176 links, to be set off from the line P n perpendicularly toward A; consequently, P G is the true line of division, and the trapezium P G E D contains B's share.

Now, the irregular polygon A B F P G contains C's share, which will be found = 4A. 3R. 19P.

By the scale, we find A G = 252, and B F = 545 links, which distances must be measured in the field, in order to determine the situations of the division-fences.

Note 1.—The foregoing example may also be performed by subtracting the area of the triangle C D P from A's share; and then laying out the remainder in the triangle C F P, as before directed.

In a similar manner, may be parted off B's share.

2.—The division of the last, or any other figure, may be proved by finding the area of the whole figure, which, if equal, or nearly equal to the sum of the areas of the parts into which it has been divided, demonstrates the work to be right.

PROBLEM VI.

To divide a Common, or any quantity of Land, of uniform Value, among any number of Proprietors, in the proportion of their respective Interests.

In this case, the land to be divided must first be surveyed; and next, the estate of each proprietor, if its quantity be unknown. Then, if it be required to make the division according to the value of each person's estate; there must be proper persons appointed to value them, which, in this Problem, we will suppose, may be done at so much per acre, uniformly, throughout each estate.

Note 1.—When the land to be divided is of uniform value, nothing more is wanted than its quantity.

2.—It is immaterial whether the land be valued at 5s. or 5l. per acre, if the same proportion, according to the quality of the land, &c. be observed in valuing each person's estate.

To determine each Person's share.

RULE.—As the number of acres, &c. contained in the sum of the estates, is to the whole quantity of land to be divided, so is each person's estate to his respective share. Or, as the sum of the values of all the estates, is to the whole quantity of land to be divided, so is the value of each person's estate to his respective share.

EXAMPLES.

1. Divide a common containing 56A. 2R. 16P. among three persons, A, B, and C, whose estates are 58, 96, and 128A. respectively.

Here $58+96+128=282$, the number of acres contained in all the estates; and 56A. 2R. 16P. $=$ 5660000 square links. Then,

$$\text{as } \overset{\text{A.}}{282} : \overset{\text{sq. links.}}{5660000} :: \overset{\text{A.}}{\left\{\begin{array}{r}58\\96\\128\end{array}\right\}} : \underset{\underline{\underline{5659999}}}{\overset{\text{sq. links.}}{\left\{\begin{array}{r}1164113\\1926808\\\underline{2569078}\end{array}\right\}}} = \underset{\underline{\underline{56\ \ 2\ \ 15.8}}\text{ proof.}}{\overset{\text{A.}\ \ \text{R.}\ \ \text{P.}}{\left\{\begin{array}{rrr}11&2&22.5\\19&1&2.8\\25&2&30.5\end{array}\right\}}} \left.\begin{array}{l}\text{A's}\\\text{B's}\\\text{C's}\end{array}\right\}\text{share.}$$

Each person's share thus determined, the common may easily be divided by the methods already described.

2. Three gentlemen, A, B, and C, have each an estate consisting of 300A.; divide among them, according to the values of their estates, 75A. 3R. 32P.; A's estate being valued at 25s., B's at 32s., and C's at 40s. per acre, per annum.

$$\text{Here } 300 \times \overset{\text{s.}}{\left\{\begin{array}{r}25\\32\\40\end{array}\right\}} = \overset{\text{s.}}{\left\{\begin{array}{l}7500 \text{ the value of A's estate.}\\9600 \text{ ditto of B's.}\\\underline{12000} \text{ ditto of C's.}\\\underline{\underline{29100}} \text{ sum.}\end{array}\right.}$$

And 75A. 3R. 32P. $=$ 7595000 square links. Then,

$$\text{as } \overset{\text{s.}}{29100} : \overset{\text{sq. links.}}{7595000} :: \overset{\text{s.}}{\left\{\begin{array}{r}7500\\9600\\12000\end{array}\right\}} : \underset{\underline{\underline{7594999}}}{\overset{\text{sq. links.}}{\left\{\begin{array}{r}1957474\\2505567\\\underline{3131958}\end{array}\right\}}} = \underset{\underline{\underline{75\ \ 3\ \ 32}}\text{ proof.}}{\overset{\text{A.}\ \ \text{R.}\ \ \text{P.}}{\left\{\begin{array}{rrr}19&2&12\\25&0&9\\31&1&11\end{array}\right\}}} \left.\begin{array}{l}\text{A's}\\\text{B's}\\\text{C's}\end{array}\right\}\text{share.}$$

Note.—It sometimes happens that two, three, or more persons join in taking a common pasture, and agree to pay in proportion to the number of cattle with which each person depastures. In such cases, when the whole of the cattle graze an equal time, you must make use of the rule of Single Fellowship, by saying, as the whole of the cattle, is to the rent of the whole pasture, so each person's cattle to his share of the rent. But when the cattle graze an unequal time, you must then have recourse to the rule of Double Fellowship, by saying, as the sum of the products of each person's cattle and time, is to the whole rent, so is each person's product to his share of the rent.

PROBLEM VII.

To divide a Common, &c. of variable Value, among any Number of Proprietors, in the Proportion of their respective Interests.

In a work of this kind, the quantity of every different quality is required, not only of the land to be divided, but also of each proprietor's estate; consequently, the Surveyor, accompanied by the persons appointed to value, generally called "Commissioners," must examine each person's estate, and also the Common, previously to the survey being taken.

In doing this, they must stake out lines between the different qualities of the soil; and, in surveying, these lines (called by Surveyors, "Quality-lines") must be considered as boundaries, and represented in the field-book, and upon the plan, by small dashes.

By way of distinction, there ought to be two stakes put down at each angle formed by the quality-lines; and also marks cut in the ground, pointing in the direction of these lines, so that if the stakes should be pulled up, these marks may serve as directors.

When the survey is finished and laid down, every different quality, represented upon the plan, must be successively numbered, 1, 2, 3, &c. The Surveyor must then require the Commissioners to put the different valuations upon the land; and, in doing this, he must accompany them with the plan, in order that both he and they may know the ground corresponding with each number. Surveyors generally use letters to represent the different values of land:

Thus, a, may denote 1 shilling.
b 2
c 3
d 4
e 5
f 6
g 7
h 8
i 9
o 10
s 20
and x............ 30 shillings.

By putting three of these letters together, and adding their separate values, the value per acre per annum, may be set down as high as sixty shillings; and, by adding more letters, it may be carried to any height required. By the use of these letters the confusion, arising from a multiplicity of figures, is avoided.

The land being valued, you must then proceed to find the quantity contained under each number on the plan; and also its value.

In doing this, it is unnecessary to bring the decimals into roods and perches, or to retain more of them than the three next the acres; as the operation is thus considerably simplified.

If the fourth figure in the decimals be 5, or greater, add 1 to the third: that is, if the content be 3.54585, set down 3.546.

When the content does not amount to an acre, and the number of decimals is under five, add as many ciphers to the left, as will complete that number: that is, if the content be .8626, set down .086. Then, multiply the acres and decimals, contained in each number, by the valuation per acre, put upon the respective numbers, and the product will be the value in shillings and decimals.

MISCELLANEOUS OBSERVATIONS ON VALUING LAND.

1. Proprietors ought to be very judicious in appointing Commissioners, to value for an inclosure. They should not only be well acquainted with the quality of the soil; but should also be

able to judge how far every part of the Common is capable of being improved, after it has been inclosed, or they will not be able to put a just valuation upon it

2. In valuing, not only the quality of the land, but also its situation, must be attended to; for, if one part of the land to be divided, lies in a valley, (not subject to be flooded,) near a proprietor's messuage, and another part upon a hill, at the distance of two or three miles; it is evident, allowing the land to be all of the same quality, that the former situation is much more desirable than the latter; because it is nearer the house-stead, and consequently better situated for receiving agricultural improvements.

3. The manner in which the climate and seasons may operate upon the produce of the ground, in consequence of its local situation, should always be taken into consideration. If one field lie towards the south, and another towards the north, and both be of the same quality; the field that faces the south is more valuable than the other, as the crops on the former will not only be brought to a greater degree of perfection by the benign influence of the sun, but will also be ready for the sithe or sickle much sooner; and consequently may be brought to an earlier, and frequently to a better market.

4. In valuing a Common for an inclosure, the improvements that may be made by fencing, draining, and cultivation, should never be overlooked. If one person should have an allotment awarded to him in the best part of the Common, but where no improvement can be made; and another person's allotment, of equal value, be laid out in the worst part of the Common, but where much improvement may easily be made by cultivation, it is manifest that the latter allotment will, in a few years, be more valuable than the former. Besides, as quantity is always given to compensate for any deficiency in quality, the proprietor who has his common-right laid out in the worst part of the ground, will not only receive more land than the other; but will soon be able, by a trifling expense in cultivation, to make it worth more per acre.

5. In valuing either old inclosed lands or commons, the distance of the ground from good springs of water should be re-

garded. In many parts of England, and particularly upon the Wolds in Yorkshire, the occupiers of land frequently suffer great inconvenience in driving their cattle a considerable distance to watering-places; and the cattle themselves are sometimes much injured, in droughty summers, for want of a regular supply of wholesome water. Hence a farm that is well watered is worth more to rent, than another farm of equal quantity and quality, but destitute of water.

6. The distance of farms, common-rights, &c. from market-towns is also of considerable importance; because land always increases in value as it approaches the vicinity of large towns. Besides, as tillage abounds in such places, the means of improvement may be obtained at a much less expense, for ground situated in the environs of towns, than for that which lies at the distance of several miles. It may also be remarked, that the occupiers of the former can always find a ready market for the produce of their land, while the occupiers of the latter are under the necessity of being at a considerable expense in transporting their goods to market; and in procuring the various articles that are indispensably necessary for the use of their families.

Note.—Here it may not be improper to explain to the young Surveyor, a few of those terms by which commons and uninclosed lands are usually denominated.

Appellations given to Commons.

1. Moors are large, uncultivated tracts of ground, generally overgrown with furze, broom, heath, and other small shrubs, as Rumbles-moor in Yorkshire, and Blackstone-edge, partly in Yorkshire, and partly in Lancashire.

2. A Fell is a large, open portion of land, generally less overrun with shrubs than a moor, as Gateshead Fell in the county of Durham.

3. A Heath is any open ground, abounding with the plant called heath, or any other shrubs, as Hounslow Heath in Middlesex.

4. Wolds are high, open grounds, as the Wolds in Yorkshire and Lincolnshire.

5. **Downs** are fine, open, pasture grounds, as the Downs in Kent, Sussex, and Surry.

6. **Fens** are low, wet, tracts of ground, as the Fens in Lincolnshire.

7. **Marshes** are low, swampy grounds; and when adjoining the sea, or the sides of rivers, they are mostly excellent pastures; as the Marshes in the counties of Durham and York, contiguous to the river Tees; those in the counties of York and Lincoln, contiguous to the river Humber; and the rich marsh of Romney, in the county of Kent, adjoining the straits of Dover.

8. **Mosses** are black, turfy, boggy moors, as Ashton Moss, and many others in Lancashire.

9. **Forests** are wild, uncultivated tracts of ground, generally abounding with trees, as Sherwood Forest, in Nottinghamshire, and the New Forest, and that of East Bere, in Hampshire.

10. **Ings** are large, open meadows, generally situated on low, level grounds. Fields and tracts of land known by the local name of "The Ings," abound in almost every county of England.

11. **Holmes** are hilly, fenny, or level grounds, adjoining to, or encompassed by rivulets or brooks. Many rich and fertile pasture grounds, in this country, are known under the local appellation of "The Holmes."

12. **Open-Fields** are uninclosed lands, generally divided into furlongs, by mereforms; and occupied by different tenants.

Some furlongs are usually in corn, some in meadow, and others in pasture; and the cattle and sheep which depasture, are tended by shepherds. Large tracts of land upon the Wolds, in Yorkshire, are cultivated in this manner.

13. A **Furlong** of land is used, in some old books, to express the eighth part of an acre; hence 20 perches or 605 square yards, make a furlong.

The term is also used to denote any number of lands adjoining each other, in open-fields, and running in the same direction from one head-land to another; and known by some particular name, in order to distinguish the different parts of the field from each other.

14. MEREFORMS are narrow pieces of swarth, dividing lands, or furlongs, in open-fields, from each other.

15. AN OX-GANG, or *Ax-gate* of land is usually taken for 15 acres; being as much land as it is supposed one ox can plough in a year.

In Scotland, 13 acres are denominated an Ox-gang; and in some places, the term is used to denote as much land as will summer one ox.

This word is corruptly called *Osken* in Lincolnshire, and some other counties.

16. A HIDE of land, sometimes met with in old books, was such a quantity as might be cultivated, in the compass of a year, with one plough; having meadow and pasture sufficient to feed the cattle belonging thereto. The term was also frequently used to denote as much land as would maintain a family.

Some writers make the hide to contain 60, some 80, some 100, and others 120 acres.

Sir William Dugdale, the antiquarian, says that a Barony, in former ages, was a certain portion of land held immediately of the king, and contained not less than 40 hides, or 3840 acres; a statement that gives 96 acres to a hide.

Directions for setting out new Roads, Sand-Pits, Quarries, Watering-Places, &c. &c.; and for dividing Commons and Waste Lands into Allotments.

1. Before commons and waste lands are divided and allotted, new roads must be set out upon them, in the most convenient and advantageous manner. They should, whenever it is practicable, be set out in such directions as to form right-angles, or as nearly right-angles as possible, as the places where they meet or

intersect each other, or come in contact with ancient highways. They should not be less than thirty feet in breadth; and set out in right-lines; because straight roads not only look better than crooked ones, but also occupy less ground.

2. All old roads leading over commons or waste lands about to be inclosed, may be stopped or diverted, at the discretion of the commissioners, and such old roads must be surveyed and allotted as part of the commons or waste lands.

3. Certain portions of commons should always be set out for sand or gravel-pits, and for quarries; if the commons contain either sand, gravel, or stone. The portions of ground thus set out are considered as public property, from which every person who receives a common-right, may take materials for building houses, making fences, and repairing roads.

4. If there be any good springs of water on commons, they must either be left uninclosed, for public watering-places; or the water must be conveyed to more convenient situations, by means of drains or channels; and troughs or reservoirs made for its reception.

5. In some places the lord of the manor claims one-twelfth, in some one sixteenth, in others only one-twentieth, of all commons and waste lands; whatever be his claim, however, it must be set out before any other allotment, after its value has been ascertained from the quantity and value of the whole common. Besides this allotment, the lord of the manor, will, of course, be entitled to his proportional share of the remainder of the waste lands, in the same manner as any other proprietor.

6. When it can be done, it is very desirable to ascertain the value of all the tythes, and to set out, for the proprietor of the tythes, an allotment of equivalent value; thus will the whole place become tythe-free; and the occupiers of lands be exempt from what they generally deem an unpleasant tax upon their industry; but which is, nevertheless, as justly due to the proprietor of the tythes, as the rent of a farm is to the landlord.

7. If the clerk's salary arise from the lands, which is the case

in some places, a common-right may also be set out in lieu of it; and if another can be obtained as a small endowment for a town's school, the inhabitants will not have cause to repent, if they be judicious in the choice of a master.

8. After the roads, sand-pits, quarries, watering-places, manorial right, &c. &c. have been set out, the remainder of the common or waste lands must be equitably divided, (quantity, quality, and situation of place being regarded,) among the owners and proprietors of messuages, cottages, lands, tenements, and hereditaments situated in the township or place where the inclosure is to be made and executed.

Note 1.—The first step towards inclosing wet, marshy grounds, is to have them well drained; for without this be done, every attempt at improvement will be vain. Mr. Elkington's method of draining land, drawn up by Mr. Johnstone, (price twelve shillings in boards,) and published under the direction of the Board of Agriculture, has eclipsed every other work on this subject.

See my Treatise on Practical Mensuration, Part VI., for a particular account of Mr. Elkington's manner of draining; for the great agricultural improvements lately made in the counties of York and Lincoln, by means of extensive drainages; and for the method of measuring hay-stacks, drains, canals, marl-pits, ponds, mill-dams, embankments, quarries, and coal-heaps.

2.—As Land-Surveyors are frequently employed to measure and value standing timber, in gentlemen's estates, I beg leave to refer them to my Mensuration, Part IV., where I hope they will find these subjects satisfactorily treated.

The work also contains the Mensuration of Superficies and Solids in general; the method of measuring Artificers' Works; Conic Sections and their Solids; and the most useful Problems in Gauging.

To determine the Value of each Proprietor's Allotment, or claim upon the Common.

In doing this, the value only can be used; for, if we make use of the quantity, in allotting land of different qualities, the proprietor who has his allotment in land of the best quality, will obviously receive more than his just right; while those, whose allotments fall in land of inferior quality, lose part of their property. Hence, you must say, as the value of the whole estates, is to the value of the Common, or land to be divided, so is the value of each person's estate to the value of his allotment, or claim upon the Common.

To set off, upon the Plan, each Proprietor's Allotment, or Share of the Common.

When you find that a proprietor's allotment falls in that part of the Common, which is of uniform quality, you may easily determine the quantity to which he is entitled, by saying, as the value put upon the number in which his allotment falls, is to 1 acre, so is the value of his claim, to the quantity of land which his allotment must contain. Then set off the allotment upon the plan, by some of the methods already described.

But it commonly happens that a proprietor's allotment falls in different numbers. In such a case, you must draw a guess-line, or lines, and measure separately, by the scale, the pieces cut off belonging to the different numbers: then multiply the different quantities by their respective values, and if the sum of the products be equal to the value of the claim in question, the guess-line or lines, are right; if not, they must be altered, until they part off the exact portion. After each proprietor's allotment is set off upon the plan, if you find the quantity and value of all the allotments equal to the quantity and value of the whole Common, the division is right.

EXAMPLE.

Lay down a Plan from the engraven Field-Book, belonging to Plate XII.; and divide the Common among the three Proprietors, A, B, and C; according to the different qualities of their Estates, and of the Common.

A Book of Quantities, Qualities, Values, &c.

Belonging to Plate XII.

No. on the Plan.	A's Estate.		
	Quantity. A. Dec.	Quality.	Value. Shil. Dec.
1	7.565	x s	378.250
2	7.609	x o	304.360
3	7.301	x h	277.438
Total	22.475		960.048
	B's Estate.		
4	7.858	x g	290.746
5	7.892	x c	260.436
6	8.223	x b	328.920
Total	23.973		880.102
	C's Estate.		
7	7.819	x h	297.122
8	7.078	x s	424.680
9	7.481	x s	374.050
Total	22.378		1095.852
	The value of the whole Estates.		2936.002
	The Common.		
10	10.061	x	301.830
11	4.680	x d	159.120
12	4.446	x h	168.948
13	5.995	s h	167.860
Total	25.182		797.758

Note 1.—The learner should lay down the plan, from the field-notes, by a scale of two chains to an inch; and find the areas of all the fields from his own dimensions, as directed in Part V. The diagonals and perpendiculars from which the above areas were found, are not given, as this would have rendered the work too easy to exercise the genius of the student; he may, however, retain his own dimensions, and enter them in "a Book of Dimensions, Castings, Quantities, Qualities, and Values, adapted to Plate XII." (See the Books of Dimensions and Castings, in Part V., belonging to Plates VIII. and X.)

2.—If the learner should not be able to find such dimensions as will make his areas agree exactly with those given in the foregoing book of quantities, it will be a matter of no consequence, provided the difference be not too considerable; and as any difference in the areas will also produce a difference in the values, all the numbers in his book will differ from the given numbers. This, however, will tend much to his improvement, as he will be under the necessity of making all his own calculations, both in finding the areas and values of the different fields, and also in dividing the Common, and proving the Division.

The Operation of finding the Value of each Proprietor's Share of the Common; and Directions for setting out the Allotments in the Field.

$$\text{As } \overset{s.}{2936} : \overset{s.}{797.758} :: \left\{\begin{array}{r}\overset{s.}{960.048}\\ 880.102\\ 1095.852\end{array}\right\} : \left\{\begin{array}{r}\overset{s.}{260.860}\\ 239.137\\ 297.761\end{array}\right\}\left.\begin{array}{l}\text{A's}\\ \text{B's}\\ \text{C's}\end{array}\right\}\text{value.}$$

$$\underline{\underline{797.758}}\ \text{proof.}$$

As the whole of A's allotment will fall in No. 10, we say, as 30 : 1 :: 260.860 : 8.695 acres, the quantity of land which A's allotment must contain.

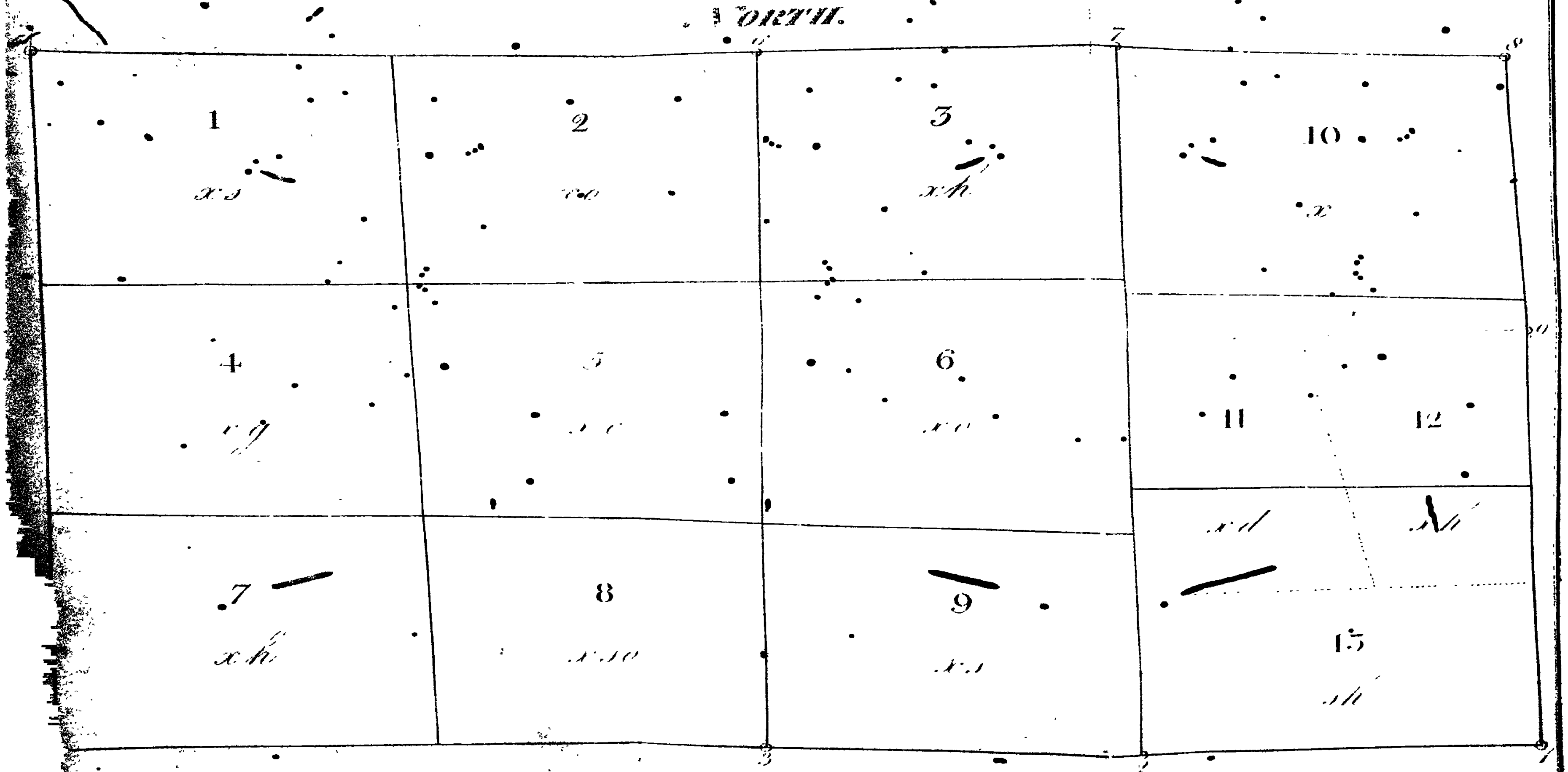
From 10.061 take 8.695, and we have 1.366, the remainder of No. 10, in value = 40.980, which will form part of B's allotment. Then, from 239.137, take 40.980, and there remains 198.157; consequently, B must have land equivalent to this value, from Nos. 11 and 12.

The remainder of these Nos. and the whole of No. 13, will be C's allotment, which you must measure, &c. as a proof.

In setting off the allotments upon the plan, we find that one end of the division-fence between the allotments of A and B, falls at the distance of 827 links from + 8 toward + 1; and the other end at the same distance from + 7 toward + 2. We find, likewise, that one end of the division-fence between the allotments of B and C, falls at the distance of 1465 links from + 8 toward + 1; and the other end at the distance of 1478

Plate XII.

A Plan from the Engraven Field Book, Page the 15th, &c.



SCALE, 4 Chains to an Inch.

links from + 7 toward + 2. Measure, therefore, these distances in the field, stake out the division-fences, and the work will be completed.

Note.—The fences of old inclosures are generally very crooked; but the fences of new inclosures are always set out in straight lines, when it is practicable.

THE PROOF OF THE DIVISION.

No. on the Plan.	Quantity. A. Dec.	Quantity. A. R. P.	Quality.	Value. Shil. Dec.
		A's Allotment.		
Part of 10	8.695	8 2 31	x	260.850
		B's Allotment.		
Part of 10	1.366	....	x	40.980
——— 11	2.580	....	x d	87·720
——— 12	2.910	....	x h	110.580
Total	6.856	6 3 16		239.280
		C's Allotment.		
Part of 11	2.100	....	x d	71.400
——— 12	1.536	....	x h	58.368
Whole of 13	5.995	....	s h	167.860
Total	9.631	9 2 22		297.628
Sum total	25.182	25 0 29		797·758

Note 1.—In dividing land by this irregular method, (the only one practicable, when an allotment falls in land of different qualities,) it is almost impossible to get the quantity and value of all the allotments to agree *exactly* with the quantity and value of the whole Common; but when the difference is trifling, we may rely upon the accuracy of the division.

2.—All the fences of the estate in Plate XII. are made straight, in order to avoid trouble in casting the contents; and as the allotments are small, neither roads, sand-pits, quarries, nor watering-places, are set out; but as copious directions have been given on these and other subjects, the Author is persuaded that if these directions be well understood, the learner will find no difficulty in performing any operation that may be wanted in conducting an extensive inclosure, so far as appertains to the business of a Land-Surveyor.

Acts of Parliament

FOR INCLOSING COMMONS AND WASTE LANDS.

ALL commons and waste lands are inclosed under Special Acts of Parliament obtained for that purpose; and the Commissioners and Surveyors are always appointed by name, in such Acts.

The preamble of a Special Act, sets forth the manor, township, parish, and county in which the commons or waste lands are situated; specifies the names of such commons and waste lands, and the quantity of ground they contain, either by survey or estimation; notices the little profit and advantage they afford in their present state; and points out the improvements they are capable of receiving, if they be divided, allotted, and inclosed.

In order to diminish the expense attending the passing of Special Acts of Inclosure, for particular places, a General Act was passed in the year one thousand, eight hundred and one, consolidating and containing certain provisions usually inserted in Special Acts of Inclosure.

This Act is made the foundation of all Special Acts, and contains the same provisions, with the exception of particular clauses that are always inserted in Special Acts of Inclosure, relating to, and making provisions for, local circumstances.

Now, in order that no necessary instructions may be wanting in this Work, relating to Inclosures, it has been thought advisable to give an abstract of the General Inclosure Act, for the information of those readers who may not have an opportunity of consulting the Act itself.

It will be found from this statute, that no person can act as a Commissioner, until he has first taken an oath that he will faithfully, impartially, and honestly, according to the best of his skill and ability, execute and perform all the trusts, powers, and authorities vested and reposed in him, as a Commissioner.

It also appears by this Act, that every person making a survey, plan, and valuation for an inclosure, shall verify the same upon oath, to the Commissioners.

The Act likewise points out the method of ascertaining the boundaries of manors or lordships; making out claims; settling disputes; setting out roads; fencing allotments; defraying the expenses of the inclosure, &c. &c.

Besides giving an abstract of the General Act, a few particular clauses are selected from Special Acts, obtained for inclosing certain commons and waste lands in the West Riding of the County of York.

GENERAL ACT.

An Abstract of an Act for consolidating in one Act, certain Provisions usually inserted in Acts of Inclosure; and for facilitating the Mode of proving the several Facts usually required on the passing of such Acts. (July 2nd, 1801.)

WHEREAS, in order to diminish the expense attending the passing of Acts of Inclosure, it is expedient that clauses usually contained in such Acts should be comprised in one law, and certain regulations adopted for facilitating the mode of proving the several facts usually required by Parliament, on the passing of such Acts: May it, therefore, please your Majesty, that it may be enacted; and be it enacted by the King's most excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, that no person shall be capable of acting as a Commissioner in the execution of any of the powers to be given by any Act hereafter to be passed for dividing, allotting, or inclosing any lands or grounds, except the power of signing, and giving notice of the first meeting of the Commissioner or Commissioners for executing any such Act, and of administering the oath or affirmation hereinafter directed, until he shall have taken and subscribed the oath or affirmation following:

'I, A. B. do swear (or being one of the people called *Quakers*, do solemnly 'affirm), that I will faithfully, impartially, and honestly, according to the best 'of my skill and ability, execute and perform the several trusts, powers, and 'authorities vested and reposed in me as a Commissioner, by virtue of an Act 'for (*here insert the title of the Act*), according to equity and good conscience, 'and without favour or affection, prejudice or partiality, to any person or per'sons whomsoever. So help me God.'

Which oath or affirmation it shall be lawful for any one of the Commissioners, where more than one shall be appointed by any such Act, or any one Justice of the Peace for the county within which the said lands or grounds shall be situated, where only one Commissioner shall be so appointed, to administer, and the said oath and also the appointment of every new Commissioner, shall be enrolled with the award, and a copy of the enrollment admitted as evidence.

2. Commissioners declining to act, shall give notice, in writing, of such intention, to the other Commissioners; and no such Commissioner shall be capable of purchasing any lands within any parish in which the inclosures are to be made, until five years after the date and execution of the award to be made by any such Commissioner, or Commissioners.

3. And whereas disputes may arise concerning the boundaries of parishes, manors, hamlets, or districts, to be divided and inclosed, and of others adjoining thereto, Commissioners shall inquire into the boundaries of parishes, and if not sufficiently ascertained, they shall fix them, giving previous notice of their intention so to do.

The Commissioners shall cause a description of boundaries to be delivered to one of the Church-Wardens, or Overseers of the poor of the respective parishes, and to the Lords of Manors or their stewards; and if any such person or persons be dissatisfied with the determination respecting the said boundaries, they may appeal to the quarter-sessions, the decision of which is to be final.

4. A true, exact, and particular survey, admeasurement, plan, and valuation of all the lands and grounds to be divided, allotted, and inclosed by any such Act; and also of all the messuages, cottages, orchards, gardens, homesteads, ancient inclosed lands and grounds within any such parish or manor, shall be made, and kept by the Commissioners; and the same shall be verified upon oath or affirmation by the person making such survey, valuation, &c. at any meeting to be held after the making thereof.

Proprietors, and their agents, may inspect admeasurements and plans, and take copies or extracts therefrom.

5. Until the division shall be completed, the lands may be entered by the Commissioners, or any persons they may appoint to make surveys, valuations, &c. &c.

Maps made at the time of passing Acts, may be used, without making new ones, if the Commissioners shall think fit.

6. All persons who shall have or claim any common or other right to or in any such lands to be inclosed, shall deliver to the Commissioners schedules of particulars, or shall be excluded; and such claims may be inspected, and copies taken.

Objections to claims to be delivered to the Commissioners at or before the meeting appointed for that purpose, or they shall not be received, except for special cause.

7. Commissioners are not hereby authorised to determine disputes touching rights; but they shall assign the allotments to the persons in actual possession of the land.

8. Commissioners before making any allotments are to set out and appoint the public carriage-roads and high-ways, through and over the lands and grounds intended to be divided, allotted, and inclosed; and to divert, turn, and stop up

any of the roads and tracts upon any part of the said lands, as they shall judge necessary, so as such roads and highways shall be and remain thirty feet wide at the least, and the same shall be set out in such directions as shall appear to them most commodious to the public. They shall also ascertain the same by marks and bounds; and prepare a map thereof to be deposited with their Clerk, and give notice thereof, and appoint a meeting, at which, if any person shall object, the Commissioners with a Justice of the Division shall determine the matter.

If the Commissioners by any Bill shall be empowered to stop up any old road, it shall not be done without the order of two Justices, which order shall be subject to appeal to the Quarter Sessions.

9. The carriage-roads shall be well fenced on both sides, by such of the land-owners as the Commissioners shall direct; and no person shall erect any gate across any road, or plant any trees on the sides, at less than fifty yards distance.

The Commissioners shall appoint Surveyors of the roads, and if with a salary, such salary, and the expense of making the road, over and above the statute duty, shall be raised in the same manner as the charges and expenses of obtaining and passing any such Act; and shall be directed to be raised and paid to such Surveyors on or before the execution of the award.

Surveyors of roads are directed to be in all respects subject to the controul of the Justices of the Peace, acting in and for the county in which such roads shall respectively lie; and shall account to such Justices for all monies received and expended; and for the re-payment of any surplus which may remain in their hands, to such persons as shall have been made liable to contribute thereto, according to the proportion so as above ascertained by such Commissioners; and such Justices shall have the power of levying any such rates as may be thought necessary for the purpose aforesaid, according to the proportions previously ascertained by the Commissioners.

If Surveyors neglect to complete roads within a limited time, they shall forfeit £20, and the inhabitants shall not be charged or chargeable towards forming or repairing the said roads, (except statute duty,) till such time as the same shall be declared to be completed, at a Special Sessions.

10. Commissioners are empowered and required to set out and appoint such private roads, bridleways, footways, ditches, drains, watercourses, watering-places, quarries, bridges, gates, stiles, mounds, fences, banks, bounds, and landmarks, in, over, upon, and through or by the sides of the allotments to be made, as they shall think requisite, giving such notice, and subject to such examination as may be required. And the same shall be made and at all times kept in repair, by the owners and proprietors, for the time being, of the lands and grounds directed to be divided and inclosed, in such proportion as the Commissioners shall, by their award, order and direct.

11. The grass and herbage on roads shall belong to the proprietors of the lands adjoining on either side; and all roads which shall not be set out as aforesaid shall be stopped up, and be deemed and taken as part of the lands and grounds to be inclosed; and shall be divided, allotted, and inclosed accordingly.

No turnpike-road shall be altered or diverted without the consent of the trustees of such turnpike-road.

12. Commissioners, in making the several allotments, shall have due regard as well to the situation of the respective houses or homesteads of the proprietors, as to the quantity and quality of the lands and grounds to be allotted to them respectively, so far as may be consistent with the general convenience of the said proprietors; and the Commissioners, in making the said allotments, shall have particular regard to the convenience of the owners or proprietors of the smallest estates, in the lands and grounds directed to be allotted and exchanged.

13. And whereas the proprietors and persons interested in open common-fields, meadows, pastures, commons, and waste lands, directed to be divided and allotted, whose allotments thereof will be small, and expensive to inclose, may be desirous of stocking and depasturing their allotments in common, and of sharing such produce as may grow thereon, under proper regulations; therefore the Commissioners shall be fully authorised and empowered, on application of the parties interested, at their first or second meeting for receiving claims, and on an attentive view and full consideration of the premises, to award, order, and direct any such allotments to be laid together, and ring-fenced, and to be stocked and depastured in common, and to make such orders and regulations for the equitable enjoyment thereof, and for the participation of any produce growing or to grow thereon, as the Commissioners may think beneficial and proper for the said several parties interested therein.

14. The several shares of and in any lands or grounds which shall, upon any such division, be assigned, set out, allotted, and applied unto and for the several persons who shall be entitled to the same, shall, when so allotted, be and be taken in full compensation for all rights in the lands, grounds, rights of commons, and all other rights and properties whatsoever, which they respectively had, and were entitled to, in and over the said lands and grounds; which rights shall cease on notice from the Commissioners being affixed on the doors of the parish church; in which the said lands and grounds shall be situated.

15. Commissioners shall, and they are hereby authorised, to set out; allot, and award any messuages, buildings, lands, tenements, hereditaments, new allotments, or old inclosures, within such parish or manors, in lieu of or in

exchange for any other messuages, buildings, lands, tenements, hereditaments, new allotments, or old inclosures, within the said parish or manors, or within any adjoining parish or place; so that all such exchanges be made with the consent of the respective owners and proprietors, seized of the lands, &c., which shall respectively be so exchanged; or if belonging to or held in right of any church, chapel, or ecclesiastical benefice, shall also be made with the like consent, in writing, of the bishop, the patron, &c. for the time being; and all such exchanges shall be for ever good, valid, and effectual in the law, to all intents and purposes whatsoever.

16. Commissioners may make allotments in severalty to joint tenants, or tenants in common; and immediately after the said allotments shall be made and declared, the same shall be holden and enjoyed by the person or persons to whom the same shall be allotted in severalty, in the same manner, and subject to the same uses, as the undivided part or shares of such estates would have been held in case such partition and division had not been made.

17. All persons to whom any allotments shall be made, are required to accept of their respective allotments within the space of two calendar months next after the execution of the award, directed to be made [illegible] in case any persons shall neglect or refuse to accept of their share or allotment within the time before-mentioned, such persons so neglecting or refusing shall be totally excluded from having or receiving any estate or interest, or right of common whatsoever, in any part of the lands and grounds to be divided and inclosed.

18. It shall and may be lawful for the respective guardians, husbands, trustees, committees, or attorneys, of any persons being minors, femes covert, lunatics, beyond the seas, or otherwise incapable by law, to accept any such allotments as shall be made by any such act, to and for the use of such persons so incapacitated as aforesaid; and also that any persons entitled to any allotments as tenants for lives, shall be, and are hereby respectively enabled and required to accept of and take such allotments.

The non-acceptance of any guardians, husbands, &c. &c., shall not exclude, or in any way prejudice the right of any person, incapacitated as aforesaid, who shall claim or accept such share or allotment within twelve calendar months next after such incapacity shall be removed.

19. After the allotments shall be set out by such Commissioners, and at any time before the execution of their award, it shall be lawful for any persons to whom any allotments shall be so made, and staked, and marked out, by and with the consent of such Commissioners, in writing under their hands, to ditch, fence off, and inclose their respective allotments, in such manner as such Commissioners shall so direct and appoint.

20. The timber trees and other trees, thorns, and bushes, standing and growing upon any waste lands, or other lands to be allotted by such act, shall be allotted and go along with the lands whereon they respectively stand, and shall be deemed the property of the several persons to whom the same lands shall be respectively allotted, such persons paying to the owner or respective owners of the said trees, such sums of money for the same, and at such times, and places, as the said Commissioners shall, by writing under their hands, direct; but if the said parties, who are to make such respective payments, shall neglect or refuse to make the same accordingly, then it shall be lawful to and for the respective parties who shall be entitled to have and receive such payments, to enter on the said lands, and cut down, take, and carry away to their own use, the said trees, thorns, or bushes, in respect of which the said payments were respectively to be made to them, at any seasonable time, within one year next after such neglect or default, they doing as little damage on the said lands as may be.

21. Whenever any sum of money is, under the provision of this Act, or any such Bill, to be paid for the purchase or exchange of any lands, tenements, or hereditaments, or of any timber or wood growing thereon, and which sum of money ought [illegible] laid out in other purchases, to be settled to the same uses, it shall and may be lawful for the Commissioners, out of such sum, to defray such proportion of the expense of passing such Act, and of carrying the same into execution, as shall, if any, be charged upon any of the lands, tenements, or hereditaments so sold or exchanged. And if the surplus money shall amount to the sum of £200, it shall, as soon as convenient, be laid out in other purchases, and in the mean time, until such purchase can be made, such money shall be paid into the Bank of England, in the name and with the privity of the Accountant General of the High Court of Chancery, to be placed to his account there. And such money shall be applied under the direction, and with the approbation of the Court of Chancery.

22. If such money be less than £200, and shall exceed the sum of £20, it shall, at the option of the persons entitled to the rents and profits of the lands, be paid into the Bank, as aforesaid, in order to be applied in the manner before directed; or otherwise the same shall be paid at the like option, to two trustees to be named by the person making such option, and to be approved of by the Commissioners, (such nomination and approbation to be signified in writing under the hands of the nominating and approving parties,) in order that the money be applied as before directed.

23. Where such money shall be less than £20, it shall be applied to the use of the persons who would for the time being have been entitled to the rents and profits of the lands, in such manner as the Commissioners shall think proper.

24. If any persons to whom any allotments shall be made, do not accept, inclose, and fence their allotments as the Commissioners shall direct, they may cause such allotments to be inclosed and fenced, and let the same to any persons they may think proper; and they may receive the rents and profits thereof, until the expenses attending the inclosure and fencing thereof are paid; or they may charge such expenses upon the proprietors of the allotments, by any such writing as aforesaid, or by their award, appoint to whom, and at what times the same shall be paid.

25. It shall be lawful for the several proprietors of the allotments to be made in pursuance of any such Act, their agents or workmen, at any seasonable times, within the space of seven years next after the fencing of any allotments, to set up and erect posts and rails, or other dead fences, on the outside of the ditches bounding their respective allotments, not exceeding three feet from such ditches, for the preservation of their quickset-hedges; and at any seasonable times, before the expiration of the said term, to take and carry away the materials of such outside fences, when they shall think proper.

26. No fences or hedges standing when any act is passed, shall be cut down or destroyed by the owners thereof, until the execution of the award, without the consent of the Commissioners; and if assigned by them as a boundary or division-fence to and for any of the allotments, all such fences or hedges shall be left uncut, for the benefit of the persons to whom such allotments shall belong; and they shall make such compensation to the former owners thereof, as the Commissioners shall, by writing under their hands, in that behalf order and appoint.

27. No proprietor whose allotments or shares shall, upon any such inclosure, lie and be situated next and adjoining to any common-fields, or inclosed grounds, the boundary of which shall be fenced by any mound, fence, brook, or rivulet, shall be compelled to make or erect any hedges, ditches, or fences, next adjoining to any such common-fields, or inclosed grounds, for inclosing such their allotments or shares; but that the whole mound, fence, brook, or rivulet, or other sufficient fences which divide any such common-fields, or inclosed grounds from such allotments, shall for ever be and remain a boundary fence for the purpose of such division; and shall from time to time be maintained, kept, cleansed, scoured, and repaired by the respective proprietors thereof, in the same manner as the Commissioners shall order and direct.

In case it shall happen that some of the proprietors shall have a greater proportion of fences to make and maintain upon any of the lands directed to be divided and inclosed, than, in the judgment of the Commissioners, they ought to be charged with, it shall be lawful for the Commissioners, where they shall judge it proper, to ascertain and appoint such sum of money to be paid to every such proprietor, towards making and maintaining such fences, by such other of the proprietors who may have a less proportion of fencing, according to the value and quantity of the lands to be allotted to them; and to grant such other relief in respect thereof, out of the money to be raised for defraying the expenses of carrying such Act into execution, as they shall think reasonable, in order that the said boundary fences may be brought as near as may be to a just and equal proportion.

28. In case any person shall wilfully and unlawfully break down, destroy, carry away, or damage any fence, stile, post, rail, gate, bridge, or tunnel, which may be put or placed under the authority of any such Act, every person so offending, and being thereof convicted before any Justice of the Peace for the County in which the lands or grounds to be inclosed shall be situated, on confession or on proof of the offence, by oath of one or more credible witnesses, (which oath the said Justice is hereby authorised to administer,) shall for every such offence forfeit and pay any sum not exceeding £5; and every person shall be allowed to give evidence of such offence, notwithstanding he may be a proprietor or occupier of lands within, or an inhabitant of such parish, and notwithstanding he may be the owner of any such fence, stile, &c. &c. to be recovered as hereinafter provided.

29. If it shall be provided by any such Act, that the expenses of obtaining and carrying the same into execution, shall be paid in proportion, by the proprietors of lands or grounds to whom any allotments shall be made; then and in such case, when and so often as any such persons, except those exempted from payment of any such charges and expenses, shall refuse or neglect to pay their proportion of the charges or expenses, or shall refuse or neglect to pay the expenses attending the inclosing and fencing of any such allotments, as upon the neglect or refusal of the proprietors, shall be inclosed and fenced by the Commissioners, as hereinafter mentioned, at the respective days and times to be appointed for payment of such charges and expenses, it shall be lawful for such Commissioners, by any warrants under their hands and seals, directed to any persons whomsoever, to cause the said costs, charges, and expenses, and sum or sums of money respectively, to be levied by distress and sale of the goods and chattels of the persons so making default in payment as aforesaid, their guardians, husbands, trustees, committees, or attorneys, wheresoever the same shall be found, rendering the overplus (if any) on demand, to the owners of such goods and chattels, the reasonable charges of such warrant, distress, and sale, being first deducted, together with the interest, after the rate of *£5 per centum per annum*, to be computed on such shares or proportions, from the time the same shall be directed to be paid by such Commissioners as aforesaid; or otherwise it shall be lawful for such Commissioners, or any persons authorised by them, to enter upon and take possession of the premises so to be allotted to such persons refusing or neglecting to pay as aforesaid, and to receive and take the rents and profits thereof, until thereby,

therewith, or otherwise, the shares or proportions, and the said costs and charges so ordered and directed by such Commissioners to be paid by such persons as aforesaid, and all interest on such shares or proportions, to be computed from the time the same shall, by such Commissioners, be directed to be paid as aforesaid; and also costs, charges, and expenses, occasioned by attending such entry upon and perception of the rents and profits of the said premises, shall be fully paid and satisfied.

30. And in such case as last aforesaid, it shall be lawful for the husbands, guardians, trustees, committees, or attorneys of any of the owners or proprietors of such allotments or exchanged lands, (except the rector or vicar of such parish) to charge such allotments or exchanged lands and premises, with such sums of money as such Commissioners shall, by their award, or by writing under their hands, either before or after the execution of such award, adjudge necessary to pay and defray the said respective shares of the charges and expenses incident to and attending the obtaining such Act, and carrying the same into execution, and of charging the said lands as aforesaid, so that the same shall not exceed £5 for every acre of such allotments or exchanged lands; and to grant, mortgage, surrender, lease, or demise, or otherwise subject the lands, tenements, and hereditaments so to be charged, unto such persons who shall advance and lend the same respectively, their executors, administrators, and assigns, for any term or number of years; or in case any person in possession, who shall or may be liable to and charged with a share of the expenses as aforesaid, shall choose to advance, pay, and discharge such sums of money, then it shall be lawful for the Commissioners, by any deed of writing under their hands and seals, to be attested by two or more credible witnesses, in like manner to grant, mortgage, surrender, lease, demise, or otherwise subject the said lands, tenements, and hereditaments, to such persons, respectively paying and discharging the same, for any term or number of years, to and for the payment of such sums of money so advanced, paid and discharged by them, with interest for the same, to commence on the termination of their right in the premises; so that every such grant, mortgage, surrender, lease, or demise, be made with a proviso or condition to cease and be void, or with an express trust to be surrendered or re-assigned, when such sums of money thereby to be secured, should be fully paid and satisfied; and also with a covenant to pay and keep down the interest, so that no persons afterwards becoming possessed or entitled to any such lands, &c. shall be liable to pay any further or larger arrear of interest than for six calendar months preceding the time when the title to such possession shall have commenced; and that every such charge, grant, mortgage, &c. shall be good, valid, and effectual in the law, for the purpose thereby intended.

31. And whereas in such cases as aforesaid, where provision may be made in any such Act for charging the expenses of passing such Act, or of executing

the powers therein contained, or of fencing the respective allotments, on the several proprietors thereof, it may be more convenient for the feoffees or trustees of any charity lands or school lands, to have lands deducted from the respective allotments, to be made for such charity or school lands, paying the proportionate share in respect of such allotments, of such expenses respectively, than to raise money on mortgage for those purposes; therefore, it shall be lawful for any such Commissioners, if they shall judge it right or expedient, to deduct from the respective allotments to be made to such feoffees or trustees as aforesaid, so much land as shall, in the judgment of such Commissioners, be equal in value to their respective proportions of the said expenses; and to allot, assign, and award the same to such persons as such Commissioners shall think proper, and who will undertake to pay and defray, and shall pay and defray, all such expenses.

32. In case it shall be provided by any such Act, that the expenses attending the same shall be paid by sale of any part of the lands so to be inclosed, the said Commissioners shall mark and set out such parts of the said waste or common lands, as in their opinion, will by sale thereof raise a sum of money sufficient to pay and discharge all such charges and expenses, as may, by any such Act, be directed to be paid and discharged out of the same; and the Commissioners shall sell such parts of the said lands to any persons for the best prices that can be gotten for the same, by private contract, or by public auctions, to be holden for that purpose, of which six weeks' previous notice shall be given. And the persons so purchasing the same shall immediately pay (by way of deposit) into the hands of the said Commissioners, or such persons as they shall appoint, one-tenth part of their purchase-money, and pay the remainder thereof within three calendar months next after, or at such other time as the said Commissioners shall appoint. And in default thereof, the money so deposited, shall be forfeited, and shall be applied in carrying such Act into execution; and the said allotments for which the whole of such purchase-money shall not have been so paid, or for which there shall be no bidding at such auction, shall be again put up to sale, and sold in manner aforesaid, for the best prices that can be gotten for the same, or be sold by the said Commissioners, by private contract, for any sums not less than the remaining nine-tenths of the prices for which the same were respectively sold before, or the amount of one bidding above the sums at which the same were respectively put up in the said former auction; and every allotment for which the full purchase-money shall be paid, shall immediately thereupon be absolutely discharged of and from all common and other right thereon, and be vested in fee simple in, and be inclosed, and thenceforth held in severalty by such purchasers thereof respectively, as their private and absolute property; and shall be allotted accordingly, by the said Commissioners; and the said purchase-money shall be applied in defraying such charges and expenses as may be in any such Act directed to be paid and discharged by the sale of such land.

33. And, for the better enabling such Commissioners to determine the several matters and things, by this or any such Act, referred to their determination, it shall be lawful for the said Commissioners, from time to time, as they shall see occasion, by any writings under their hands, to summon and require any persons to appear before them at any time and place in such writing to be appointed, to testify the truth touching the matter in dispute between any proprietors or interested persons, or otherwise relating to the execution of the powers given by this or any such Act; and to cause a copy of such writing to be served on such persons required to give evidence, or to be left at their usual or last place of abode. And all persons so summoned, who shall not appear before the said Commissioners pursuant to such summons, (without assigning some reasonable excuse for not appearing,) or who appearing, shall refuse to be sworn or examined on oath or affirmation, which oath or affirmation the said Commissioners are hereby empowered and required to administer, (such persons having been paid the reasonable charges of their attendance,) and being thereof convicted before one of his Majesty's Justices of the Peace of the county or district in which such lands are situated, upon information thereof upon oath made before any such Justice, shall for every such neglect or refusal, forfeit and pay such sum of money, not exceeding £10, nor less than £5, as such Justice shall think fit and order.

34. Provided always, That no witness summoned to attend such Commissioners, shall be obliged to travel above eight miles from the boundary of the parish, manor, or district to be inclosed by any such Act.

35. And be it further enacted, That as soon as conveniently may be after the division and allotment of the said lands and grounds shall be finished, pursuant to the purport and directions of this or any such Act, the said Commissioners shall form and draw up, or cause to be formed and drawn up, an award in writing, which shall express the quantity of acres, roods, and perches, in statute-measure, contained in the said lands and grounds, and the quantity of each and every part and parcel thereof which shall be so allotted, assigned, or exchanged, and the situations and descriptions of the same respectively; and shall also contain a description of the roads, ways, foot-paths, water-courses, watering-places, quarries, bridges, fences, and land-marks, set out and appointed by the said Commissioners, as aforesaid; and all such other rules, orders, agreements, regulations, directions, and determinations, as the said Commissioners shall think necessary, proper, or beneficial to the parties; which said award shall be fairly ingrossed or written on parchment, and shall be read and executed by the Commissioners, in the presence of the proprietors, who may attend at a special general meeting called for that purpose, of which ten days' notice at least shall be given in some paper to be named in such Act, and circulating in the county; which execution of such award shall be proclaimed the next *Sunday* in the church of the parish in which such lands shall

be; from the time of which proclamation only, and not before, such award shall be considered as complete; and shall, within twelve calendar months after the same shall be so signed and sealed, or so soon as conveniently may be, be enrolled in one of his Majesty's Courts of Record at *Westminster*, or with the Clerk of the Peace for the county in which such lands shall be situated, to the end that recourse may be had thereto by any persons interested therein, for the inspection and perusal whereof no more than one shilling shall be paid; and a copy of the said award, or any part thereof, signed by the proper Officer of the Court wherein the same shall be enrolled, or by the Clerk of the Peace for such county, or his Deputy, purporting the same to be a true copy, shall from time to time be made and delivered by such Officer or Clerk of the Peace for the time being, as aforesaid, to any person requesting the same, for which no more shall be paid than two-pence for every sheet of seventy-two words; and the said award, and each copy of the same, or of any part thereof signed as aforesaid, shall at all times be admitted and allowed in all courts whatever, as legal evidence; and the said award or instrument, and the several allotments, partitions, regulations, agreements, exchanges, orders, directions, determinations, and all other matters and things therein mentioned and contained, shall, to all intents and purposes, be binding and conclusive, except where some provision to the contrary is herein or shall be by any such Act contained, unto and upon the said proprietors, and all parties and persons concerned or interested in the same, or in any of the lands, grounds, or premises aforesaid; and also that the said respective Commissioners, if they think it necessary, shall form or draw, or cause to be formed and drawn on parchment or vellum, such maps or plans of the said lands and grounds, the better to describe the several new allotments or divisions to be made, and premises that shall be exchanged by virtue of this Act, and which shall express the quantity of each allotment in acres, roods, and perches, together with the names of the respective proprietors at the time of such division and allotment; which said maps and plans shall be annexed to and enrolled with the said respective award, and shall be deemed and construed in every respect as and for part of the said award.

36. Commissioners shall, and they are hereby required to enter in a book to be provided for that purpose, a particular account of all sums of money received from the proprietors or others during the progress of the inclosure; and also of all the charges, expenses, and disbursements which shall accrue or be made by virtue of any such Act, and in carrying the same into execution; which book of accounts shall be kept at the office of their Clerk, open at all seasonable times during the progress of the inclosure, and till all the accounts are finally settled, for the inspection of any of the proprietors, without fee or reward; and in case any such Commissioners, or their Clerk, shall neglect to provide and keep such book of accounts as aforesaid, or refuse the inspection thereof to any of the proprietors at seasonable times in manner before men-

tioned, and shall be convicted thereof, upon the oath of one or more credible witnesses not interested in the intended division and inclosure, before any Justice of the Peace of the County in which the lands or grounds to be inclosed shall be situate, or of any such other county or place where such Commissioners or Clerk so causing such neglect or refusal, and convicted as aforesaid, shall forfeit and pay for every such offence any sum not exceeding £10, nor less than £5, to be levied, recovered, and applied in the same manner as other penalties are by this Act directed to be levied, recovered, and applied.

37. All monies raised under any Act shall from time to time, as often as the same shall amount to the sum of £50, be deposited in the hands of some banker or such persons as shall be approved by a majority in value of the proprietors, at the first meeting of the Commissioners, in the notice of which meeting shall be expressed the intention of then appointing such banker, or such other persons, and no monies deposited or paid into the hands of such banker or other persons, to be appointed as aforesaid, shall be issued or paid by them, without an order in writing under the hands of such Commissioners, specifying the persons to whom the same are respectively payable, and the service or consideration for which the same are due; and the balance, if any, upon the final settlement of accounts, shall be immediately repaid to the landowners in proportion to the sums respectively paid by them.

38. It shall be lawful for the rector or vicar of any parish wherein the lands and grounds intended to be inclosed shall be situate, by indenture under his hand and seal, with the consent of the bishop of the diocese, and of the patron of the living, to lease or demise all or any part or parts of the allotments to be set out and allotted to any such rector or vicar, to any persons whomsoever, for any term not exceeding twenty-one years, to commence within twelve calendar months next after the executing the award; so that the rents for the same shall be thereby reserved to the rector or vicar for the time being, by four equal quarterly payments in every year; and so that there be thereby also reserved and made payable to such rector or vicar, the best and most improved rents that can reasonably be gotten for the same, without taking any fine, foregift, premium, sum of money, or other consideration, for the making or granting any such lease or demise; and so that no such lessee by any such lease or demise be made dispunishable for waste, and so that there be inserted in every such lease, power of re-entry on non-payment of the rents to be thereby reserved, within a reasonable time to be therein limited, after the same shall become due; and so that a counterpart of such lease be duly executed by the lessee or lessees to whom such lease shall be so made as aforesaid; and every such lease shall be valid and effectual.

39. All penalties and forfeitures imposed by virtue of this or any other such Act, shall be levied and recovered before any one Justice of the Peace

for the county in which the lands or grounds to be inclosed shall be situate, and residing near any such parish, and not interested in the matter in question; for which purpose it shall be lawful for any such Justice of the Peace, upon complaint made to him, to summon the party accused, and the witnesses on both sides; and upon the appearance or contempt of the party accused, to examine such witnesses upon oath, (which oath any such Justice is hereby empowered to administer,) and upon such evidence to give judgment accordingly, and to condemn the party accused in such penalties and forfeitures as the offenders shall have incurred, and to levy such penalties and forfeitures by distress and sale of the offender's goods and chattels, together with reasonable costs; all which penalties and forfeitures, if not directed to be otherwise applied, shall so soon as the same shall be levied, be paid for such uses as the Commissioners shall by writing under their hands or by their award, order and direct.

40. Nothing in such Act contained shall lessen, prejudice, or defeat the right, title, or interest of any lord or lady of any manor or lordship, within the jurisdiction or limits whereof the lands and grounds to be divided and allotted are situate; or to the seniorities, rights, and royalties incident or belonging to such manor or lordship, or to the lord or lady thereof, or to any person claiming under them; but the same shall remain, in as full, ample, and beneficial manner, to all intents and purposes, as they might or ought to have held or enjoyed such rights before the passing of such Act, or in case the same had never been made.

41. Saving always to the King's most excellent Majesty, his heirs and successors, and to all other persons, bodies politic and corporate, and their heirs, successors, executors, and administrators, all such estate, right, title, and interest as they had or enjoyed of, in, to, or out of, or in respect of the said lands, grounds, and premises so directed to be divided, allotted, and inclosed, or exchanged as aforesaid, before the passing of such Act, or could or might have enjoyed in case the same had never been made.

42. It shall and may be lawful for any two or more Justices of the Peace to take affidavits on oath or affirmation (which oath or affirmation such Justices are hereby authorised and empowered to administer) of the notices required for such bills having been given, of the consent of the parties interested therein, of the allegations contained in the preambles of such Bills, and of the quantity of the land to be inclosed; and that such affidavits shall not be subject or liable to any stamp duties whatsoever.

43. If any persons shall, in any examination, affidavit, deposition, or affirmation to be had or taken in pursuance of this Act, before such Justice or Justices, or such Commissioners, knowingly and wilfully swear or affirm any

matter or thing which shall be false or untrue; every such person so offending shall, on conviction thereof, be deemed guilty of perjury, and shall suffer the like pains and penalties, to which persons guilty of wilful and corrupt perjury are now liable.

44. And be it enacted, That all and every of the powers, authorities, directions, and provisions in this Act contained, shall be only so far effective and binding in each particular case, as they or any of them shall not be otherwise provided and enacted in any such Act hereafter to be passed as aforesaid.

SPECIAL ACTS.

Clauses selected from Special Acts, obtained for Inclosing certain Commons and Waste Lands in the West Riding of the County of York.

1. And be it enacted, That if any difference of opinion shall arise between the Commissioners appointed for setting out, valuing, dividing, and allotting the said commons and waste grounds, touching or concerning any matter or thing to be done by them by virtue of the said recited General Act, or this Act, the said Commissioners from time to time, and when and so often as such difference of opinion shall arise, shall, by writing under their hands, appoint some person (not interested in the premises) to be an umpire between them; and the matter upon which such difference of opinion may arise, shall be settled and determined by such umpire, whose determination in writing shall be binding and conclusive.

Provided always, that no person shall be capable of acting as an umpire, until he shall have taken the oath usual on such occasions.

2. And be it enacted, That the said Commissioners and the said umpire shall be paid and allowed one guinea each, and no more, for every day they shall respectively travel or attend for the purpose of this Act, over and besides all their reasonable expenses at the times of such their journeys and attendances.

3. And after the said Commissioners shall have set out and appointed the public carriage-roads and highways through and over the said commons and waste grounds, they shall set out such parts of the same, as they shall think proper, not exceeding five acres in the whole, to be used and enjoyed by the respective proprietors of the said lands, for the purposes of common watering-places for cattle, and getting stones and other materials for erecting and repairing buildings, bridges, walls, fences, and other works, for the reparation of the public and private roads. And the Commissioners shall in the next place assign, set out, allot, and award unto and for the lord of the manor, such part and parcel of the residue and remainder of the said commons and waste grounds, as shall in their judgment be equal in value to one full sixteenth part

of the said residue of the said common and waste grounds, in lieu of and as a full recompense for all such right and interest in and to the soil of the said commons and waste grounds as is not hereinafter expressly saved and reserved; and that after setting out, assigning, and allotting such sixteenth part to the said lord of the manor, the Commissioners shall set out, assign, and allot the residue of the said commons and waste grounds unto and amongst the said lord of the manor, and the said several other persons entitled to right of common or other rights and interests in and upon the said commons and waste grounds, according to the value of the ancient messuages, cottages, mills, old inclosed lands, tenements, and hereditaments, in respect whereof they are so respectfully entitled to such right of common, as aforesaid, and according to the true and real value of such other rights or interests, as aforesaid, estimating lands at their full and fair value as they are worth to be let, and messuages, cottages, mills, and other buildings at one-half only of such their respective values; but in estimating the value of messuages, cottages, and mills, no regard shall be had to any additions or improvements made within forty years last past. Provided always, that no person shall be entitled to any allotment from the said commons and waste grounds, or any part thereof, for or in respect of any messuage, cottage, mill, or other building which shall be proved to the satisfaction of the said Commissioners to have been erected at any time within sixty years next before the passing of this Act, unless such erection shall have been made upon the scite of some ancient messuage, cottage, mill, or other building which shall have been originally erected sixty years or upwards before the passing of this Act.

4. All encroachments which at any time within twenty years now last past have been made upon the said commons and waste grounds shall be deemed part thereof, and shall be divided and allotted accordingly; and in case any dispute or difference shall arise, touching any such encroachments or the extent thereof, such dispute or difference shall be determined by the said Commissioners.

5. Provided always, that the lands and grounds comprised in such encroachments shall be allotted to the persons who shall be in possession thereof, without regard to the value of such improvements as shall or may have been made thereon since such encroachments were made, in case the persons so in possession shall desire the same to be so allotted, and shall signify such desire by writing signed by them to be delivered to the said Commissioners at their first or second meeting to be holden in pursuance of this, and the said general Act; and the value of such encroachments shall be deducted from the allotments to which such persons shall be entitled under this Act, unless it shall happen that the value of such encroachments respectively (quantity and quality considered) shall be greater than the allotments to which such persons shall be entitled by virtue of this and the said recited General Act: and in that case proportionable part only of such encroachments shall be deducted therefrom,

and the residue thereof shall be sold by the said Commissioners; and if the Persons in possession of such encroachments shall not be entitled to any allotments, then the whole of such encroachments shall be sold by the Commissioners, and conveyed by them in fee simple to the purchaser or purchasers thereof, and the money arising from such sales shall be applied towards defraying the expenses of obtaining and executing this Act.

6. And from and immediately after the passing of this Act until the execution of the award of the said Commissioners, it shall not be lawful for any persons whomsoever to grave, dig, get, pare, cart, or carry away any sods or turves from any part of the commons or waste grounds aforesaid; and every person so doing, shall for every such offence forfeit and pay any sum not exceeding twenty shillings.

7. And be it further enacted, That no sheep or lambs shall be kept in any of the new inclosures (except such as are not fenced by quicksets) during the space of nine years from the execution of the said award, unless the persons keeping such sheep or lambs do, at their own expense, fence their neighbour's quicksets, adjoining the inclosures where such sheep or lambs shall be kept, so as to prevent any damage being done to such quicksets by such sheep or lambs.

8. And be it further enacted, That convenient gaps and openings shall be left in the fences and inclosures to be made by virtue of this Act, during such time as shall be allowed and fixed for making such fences as aforesaid, for the passage of cattle, carts, and carriages in and through the same, unless the said Commissioners shall order and award to the contrary, and then for such time only as they shall so order and award.

Note.—The foregoing clauses are not contained in the General Act.

SECTION III.

The Method of reducing Statute Measure to Customary, and vice versâ.

It has been before observed, that by custom the perch varies in different parts of England; and with it, consequently, varies the acre in proportion.

In Devonshire and part of Somersetshire, 15; in Cornwall, 18; in Lancashire, 21; and in Cheshire and Staffordshire, 24 feet are accounted a perch.

In the common field-lands of Wiltshire, and in some other counties, there is a customary measure of a different nature, viz. of 120, instead of 160, statute-perches to an acre; consequently, 30 perches of statute-measure, make 1 rood of customary, or 3 statute-roods 1 acre.

In some places, an acre of this measure, is called a day-work, or day's-work of land.

Note.—The utility of the following Problems will appear obvious, when we consider that in many places land is not only reaped and farmed, but also bought and sold by customary-measure.

Besides, when persons have the contents of their estates in statute-measure, it is frequently necessary to reduce them to the customary-measure of the place; and on the contrary, when the contents are in customary-measure, it may be desirable to reduce such contents to statute-measure.

General Rules for reducing Statute-Measure to Customary, and the contrary.

Rule 1.—*To reduce statute-measure to customary,* multiply the number of perches, statute-measure, by the square feet in a square perch, statute-measure; divide the product by the square feet in a square perch, customary-measure, and the quotient will be the answer in square perches.

Rule 2.—*To reduce customary-measure to statute,* multiply the number of perches, customary-measure by the square feet in a square perch, customary-measure; divide the product by the square feet in a square perch, statute-measure, and the quotient will be the answer in square perches, which reduce to roods and acres by dividing by 40, and by 4.

Note 1.—It is scarcely necessary to remark that the length of any perch multiplied by itself, will give the number of square feet in a square perch of the same measure; hence we have 16.5 × 16.5 = 272.25, the statute perch; 15 × 15 = 225, the Devonshire and Somersetshire perch; 18 × 18 = 324, the Cornwall perch; 21 × 21 = 441, the Lancashire perch; and 24 × 24 = 576, the Cheshire and Staffordshire perch.

2.—It may also be observed that 4840 square yards make 1 statute acre; 4000 make 1 Devonshire or Somersetshire acre; 5760 make 1 Cornwall acre; 7840 make 1 Lancashire acre; and 10240 square yards make 1 acre of the customary-measure of Cheshire or Staffordshire.

PROBLEM I.

To reduce Statute Measure to the Devonshire and Somersetshire Customary Measure, of 15 *Feet to a Perch, and* vice versâ.

TABLE I.

Stat. A.	Customary. A.	R.	P.	Stat. P.	Cust. R.	P.	Stat. P.	Cust. R.	P.
1	1	0	33.6	1	0	1.2	21	0	25.4
2	2	1	27.2	2	0	2.4	22	0	26.6
3	3	2	20.8	3	0	3.6	23	0	27.8
4	4	3	14.4	4	0	4.8	24	0	29.0
5	6	0	8.0	5	0	6.0	25	0	30.2
6	7	1	1.6	6	0	7.2	26	0	31.4
7	8	1	35.2	7	0	8.4	27	0	32.6
8	9	2	28.8	8	0	9.6	28	0	33.8
9	10	3	22.4	9	0	10.8	29	0	35.0
10	12	0	16.0	10	0	12.1	30	0	36.3
20	24	0	32.0	11	0	13.3	31	0	37.5
30	36	1	8.0	12	0	14.5	32	0	38.7
40	48	1	24.0	13	0	15.7	33	0	39.9
50	60	2	0.0	14	0	16.9	34	1	1.1
100	121	0	0.0	15	0	18.1	35	1	2.3
Stat. R.	Customary.	R.	P.	16	0	19.3	36	1	3.5
				17	0	20.5	37	1	4.7
				18	0	21.7	38	1	5.9
1		1	8.4	19	0	22.9	39	1	7.1
2		2	16.8	20	0	24.2			
3		3	25.2						

Note 1.—To reduce customary-measure, of 15 feet to a perch, to statute, multiply the number of square links, customary-measure, by .825417, and the product will be the answer in square links, which must be brought into acres, roods, and perches. (See a table of square links in the first Section.)

2.—When it is intended to find the area of an estate in customary-measure only, it is generally thought most convenient to take the dimensions by a chain properly adapted for that purpose. The Devonshire and Somerset chain is 60 feet; the Statute-chain 66 feet; the Cornwall chain 72 feet; the Lancashire chain 84 feet; and the Cheshire and Staffordshire chain 96 feet in length. Each of these chains is divided into 100 equal links, in the same manner as the statute-chain; consequently, the customary-measure is found by the same rules as the statute-measure.

3.—It may also be observed that the Devonshire and Somerset link is 7.2 inches; the Statute link 7.92 inches; the Cornwall link 8.64 inches; the Lancashire link 10.08 inches; and the Cheshire and Staffordshire link is 11.52 inches in length.

EXAMPLES.

1. In 25A. 2R. 20P. statute, how many acres, &c. customary-measure?

BY RULE I.

```
                      A.  R.  P.
                      25  2   20
                       4
                     ---
                     102
                      40
                     ----
                    4100
                  272.25 = 16.5 × 16.5
                  ------
                   20500
                   8200
                  8200
                 28700
                 8200                4,0
15 × 15 = 225)1116225.00|496,1
                 900       4|124  1
                 ---         --------
                 2162        31A. 0R. 1P. Ans.
                 2025
                 ----
                  1372
                  1350
                  ----
                    225
                    225
                    ---
                    ...
```

BY THE TABLE.

	A.	R.	P.
20A. =	24	0	32
5A. =	6	0	8
2R. =	—	2	16.8
20P. =	—	0	24.2
	31	0	1 Ans.

2. In 31A. 0R. 1P. customary, how many acres, &c. statute-measure?

BY RULE 2.

```
               A.   R.   P.
               31   0    1
                4
              ----
              124
                40
              -----
              4961
               225
             ------
             24805
             9922
            9922              4,0
272.25)1116225.00 |410,0
       108900      4|102.20
       ------        ---------------
        27225         25A. 2R. 20P.   Ans.
        27225         ===============
        ------
        .....00
        =======
```

BY THE NOTE.

```
            sq. links.
   30A. = 3000000
    1A. =  100000
    1P. =     625
          -------
          3100625
          .826447
         --------
         21704375
        12402500
       12402500
      18603750
     6201250
   24805000
   -------------
   25.62502.229375
           4
   -----------
    2 50008
          40
   -----------
    20.00320 Ans. 25A. 2R. 20P.
   ==========
```

3. In 159A. 3R. 26P. statute, how many acres, &c. customary-measure?

Ans. 193A. 1R. 39P.

PROBLEM II.

To reduce Statute Measure to the Cornwall Customary Measure, of 18 *Feet to a Perch, and* vice versâ.

TABLE II.

Stat. A.	Customary. A.	R.	P.
1	0	3	14.4
2	1	2	28.8
3	2	2	3.3
4	3	1	17.7
5	4	0	32.2
6	5	0	6.6
7	5	3	21.0
8	6	2	35.5
9	7	2	9.9
10	8	1	24.4
20	16	3	8.8
30	25	0	33.2
40	33	2	17.6
50	42	0	2.0
100	84	0	4.0

Stat. R.	Customary. R.	P.
1	0	33.6
2	1	27.2
3	2	20.8

Stat. P.	Cust. P.	Stat. P.	Cust. P.
1	0.8	21	17.6
2	1.6	22	18.4
3	2.5	23	19.3
4	3.3	24	20.1
5	4.2	25	21.0
6	5.0	26	21.8
7	5.8	27	22.6
8	6.7	28	23.5
9	7.5	29	24.3
10	8.4	30	25.2
11	9.2	31	26.0
12	10.0	32	26.8
13	10.9	33	27.7
14	11.7	34	28.5
15	12.6	35	29.4
16	13.4	36	30.2
17	14.2	37	31.0
18	15.1	38	31.9
19	15.9	39	32.7
20	16.8		

Note.—To reduce customary-measure, of 18 feet to a perch, to statute, multiply the number of square links, customary-measure, by 1.19, and the product will be the answer in square links.

EXAMPLES.

1. Reduce 56A. 3R. 36P. statute, to customary-measure.

BY RULE 1.

```
                  A.  R.  P.
                  56   3  36
                   4
                 ---
                 227
                  40
                ----
                9116
              272.25
              ------
               45580
             18232
            18232
          63812
         18232
         ---------------   4,0
18 × 18 = 324)2481831.00|765,9.9
              2268         -------
              ----       4|191  19.9
              ·2138        ---------------
               1944          47A. 3R. 19.9P. Ans.
               ----          ===============
               ·1943
                1620
                ----
                ·3231
                 2916
                 ----
                 ·3150
                  2916
                  ----
                  ·234
                  ====
```

BY THE TABLE.

	A.	R.	P.	
50A. =	42	0	2	
6A. =	5	0	6.6	
3R. =	0	2	20.8	
36P. =	0	0	30.2	
	47	3	19.6	Ans.

2. Reduce 47A. 3R. 20P. customary, to statute-measure.

BY RULE 2.

A. R. P.
47 3 20
4
191
40
7660
324
30640
1532
2298
4,0
272.25)2481840.00|911,6
245025 4|227 36
..31590 56A. 3R. 36P. Ans.
27225
.43650
27225
164250
163350
...900

BY THE NOTE.

sq. links.
40A. = 4000000
7A. = 700000
3R. = 75000
20P. = 12500
4787500
1.19
43087500
47875
47875
56.97125.00
4
3.88500
40
35.40000 Ans. 56A. 3R. 35.4P.

3. In 265A. 2R. 18P. statute-measure, how many acres, &c. customary-measure?

Ans. 223A. 0R. 30P.

PROBLEM III.

To reduce Statute Measure to the Lancashire Customary Measure, of 21 Feet to a Perch, and vice versa.

TABLE III.

Stat. A.	Customary. A.	R.	P.
1	0	2	18.7
2	1	0	37.5
3	1	3	16.3
4	2	1	35.0
5	3	0	13.8
6	3	2	32.6
7	4	1	11.4
8	4	3	30.1
9	5	2	8.9
10	6	0	27.7
20	12	1	15.4
30	18	2	3.1
40	24	2	30.8
50	30	3	18.5
100	61	2	37.0

Stat. R.	Customary. R.	P.
1	.. 0	24.7
2	1	9.4
3	1	34.1

Stat. P.	Cust. P.	Stat. P.	Cust. P.
1	0.6	21	12.9
2	1.2	22	13.5
3	1.8	23	14.1
4	2.4	24	14.8
5	3.0	25	15.4
6	3.7	26	16.0
7	4.3	27	16.6
8	4.9	28	17.2
9	5.5	29	17.9
10	6.1	30	18.5
11	6.7	31	19.1
12	7.4	32	19.7
13	8.0	33	20.3
14	8.6	34	20.9
15	9.2	35	21.6
16	9.8	36	22.2
17	10.4	37	22.8
18	11.1	38	23.4
19	11.7	39	24.0
20	12.3		

Note 1.—To reduce customary-measure, of 21 feet to a perch, to statute, multiply the number of square links, customary-measure, by 1.62, and the product will be the answer in square links.

2.—As the lineal Irish perch is 21 feet, and the Irish square perch 441 feet; the method of reducing English to Irish, or Irish to English measure, is precisely the same as shewn in this Problem.

EXAMPLES.

1. In 36A. 1R. 10P. statute, how many acres, &c. customary-measure?

BY RULE 1.

```
                       A.  R.  P.
                       36  1   10
                        4
                      ---
                      145
                        40
                      ----
                      5810
                    272.25
                    -----
                     29050
                    1162
                   1162
                 4067
                1162            4,0
21 × 21    441)1581772.50|358,6.7
                1323        4| 89 26.7
                ----         -----------
                .2587        22A. 1R. 26.71
                 2205
                 ----
                 .3827
                  3528
                  ----
                  .2992
                   2646
                   ----
                   .3465
                    3087
                    ----
                    .378
```

BY THE TABLE.

	A.	R.	P.	
30A. =	18	2	3.1	
6A. =	3	2	32.6	
1R. =	0	0	24.7	
10P. =	0	0	6.1	
	22	1	26.5	Ans.

2. Reduce 22A. 1R. 27P. customary, to statute-measure.

BY RULE 2.

A. R. P.
22 1 27
4
89
40
3587
441
3587
14348
14348
272.25)1581867.000(5810.3
136125
220617
217800
28170
27225
94500
81675
12825

4,0 | 581,0.3
4 | 145 10.3
36A. 1R. 10.3P. Ans.

BY NOTE 1.

sq. links.
20A. = 2000000
2A. = 200000
1R. = 25000
27P. = 16875
2241875
1.62
4483750
13451250
2241875
36.31837.50
4
1.27348
40
10.93920 Ans. 36A. 1R. 10.9P.

3. Reduce 116A. 3R. 32P. English measure, to Irish measure.
Ans. 72A. 0R. 31P.

PROBLEM IV.

To reduce Statute Measure to the Cheshire and Staffordshire Customary Measure, of 24 Feet to a Perch, and vice versâ.

TABLE IV.

Stat. A.	Customary A.	R.	P.
1	0	1	35.6
2	0	3	31.2
3	1	1	26.8
4	1	3	22.5
5	2	1	18.1
6	2	3	13.7
7	3	1	9.3
8	3	3	5.0
9	4	1	0.6
10	4	2	36.2
20	9	1	32.4
30	14	0	28.6
40	18	3	24.8
50	23	2	21.0
100	47	1	2.0

Stat. R.	Customary R.	P.
1	0	18.9
2	0	37.8
3	1	16.7

Stat. P.	Cust. P.	Stat. P.	Cust. P.
1	0.4	21	9.9
2	0.9	22	10.3
3	1.4	23	10.8
4	1.8	24	11.3
5	2.3	25	11.7
6	2.8	26	12.2
7	3.2	27	12.7
8	3.7	28	13.1
9	4.2	29	13.6
10	4.7	30	14.1
11	5.1	31	14.6
12	5.6	32	15.0
13	6.1	33	15.5
14	6.6	34	16.0
15	7.0	35	16.4
16	7.5	36	17.0
17	8.0	37	17.4
18	8.4	38	17.9
19	8.9	39	18.3
20	9.4		

Note.—To reduce customary-measure, of 24 feet to a perch, to statute, multiply the number of square links, customary-measure, by 2.1157, and the product will be the answer in square links.

EXAMPLES.

1. Required the number of acres, &c. customary-measure, in 269A. 2R. 12P. statute-measure.

BY RULE I.

A.	R.	P.
269	2	12

4

1078

40

43132

272.25

215660

86264

86264

301924

86264

4,0

24 × 24 = 576)11742687.00(2038,6.6

1152 4) 509 26.6

..2226 127A. 1R. 26.6P. Ans.

1728

.4988

4608

.3807

3456

.3510

3456

..54

BY THE TABLE.

	A.	R.	P.
200A. =	94	2	4
50A. =	23	2	21
10A. =	4	2	36.2
9A. =	4	1	0.6
2R. =	0	0	37.8
12P. =	0	0	5.6
	127	1	25.2 Ans.

2. In 127A. 1R. 26P. customary, how many acres, &c. statute-measure?

BY RULE 2.

```
              A.   R.   P.
              127  1    26
                4
             ----
              509
               40
             -----
             20386
               576
            ------
            122316
           142702
          101930          4,0
272.25)11742336.00    4313,0.7
          108900      4 1078  10.7
          ..85233       269A. 2R. 10.7P. Ans.
            81675
            -----
            .35586
             27225
             -----
             .83610
              81675
              ------
              .193500
               190575
               ------
               ..2925
```

BY THE NOTE.

```
             sq. links.
100A. =      10000000
 20A. =       2000000
  7A. =        700000
  1R. =         25000
 26P. =         16250
             --------
             12741250
               2.4157
             --------
             89188750
           6370625
         1274125
       1274125
     2548250
     ------------------
       269.56662.6250
                 4
          -------
          2.26648
               40
         --------
         10.65920 Ans. 269A. 2R. 10.6P.
```

3. Reduce 587A. 3R. 39P. statute, to customary-measure.

Ans. 277A. 3R. 27 P.

PROBLEM V.

To reduce Statute Measure to the Wiltshire Customary Measure, of 120 Perches to an Acre, and vice versa.

RULE 1.—To reduce statute-measure to customary, divide the number of perches, statute-measure, by 120, and the quotient will be acres; then divide the remainder by 30, and the quotient will be roods; and the last remainder, if any, will be perches. If the first remainder be under 30, it will be perches, and there will be no roods in the answer.

RULE 2.—To reduce customary-measure to statute, divide the number of perches, customary-measure, by 160, and the quotient will be acres; then, divide the remainder by 40, and the quotient will be roods; and the last remainder, if any, will be perches. If the first remainder be under 40, it will be perches, and there will be no roods in the answer.

Note 1.—To bring customary acres, &c. into perches, multiply the number of acres by 120, and the number of roods by 30; these two products, added to the number of given perches, will be the number of perches required.

2.—In some parts of England, land is not only reaped and farmed, but also bought and sold by this measure; and as the customary acre of 120 statute perches, or three statute roods, is frequently denominated a day's work or day-work of land, Surveyors are sometimes required to return the areas of estates in day's works, roods, and perches.

TABLE V.

Stat. A.	Customary. A.	R.	P.
1	1	1	10
2	2	2	20
3	4	0	0
4	5	1	10
5	6	2	20
6	8	0	0
7	9	1	10
8	10	2	20
9	12	0	0
10	13	1	10
20	26	2	20
30	40	0	0
40	53	1	10
50	66	2	20
100	133	1	10

Stat. R.	Customary. A.	R.	P.
1	0	1	10
2	0	2	20
3	1	0	0

Stat. P.	Cust. R.	P.
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	10
11	0	11
12	0	12
13	0	13
14	0	14
15	0	15
16	0	16
17	0	17
18	0	18
19	0	19
20	0	20

Stat. P.	Cust. R.	P.
21	0	21
22	0	22
23	0	23
24	0	24
25	0	25
26	0	26
27	0	27
28	0	28
29	0	29
30	1	0
31	1	1
32	1	2
33	1	3
34	1	4
35	1	5
36	1	6
37	1	7
38	1	8
39	1	9

Note.—In adding up the numbers taken from the above table, you must divide the number of perches by 30, and the number of roods by 4; because 30 perches of this measure make 1 rood, and 4 roods 1 acre, or 1 day's work.

EXAMPLES.

1. In 165A. 3R. 26P. statute-measure, how many acres, &c. customary?

BY RULE 1.

A. R. P.
165 3 26
4
663
40
120)26546(221
240
254
240
146
120
26 Ans. 221A. 0R. 26P.

BY THE TABLE.

	A.	R.	P.
100A. =	133	1	10
50A. =	66	2	20
10A. =	13	1	10
5A. =	6	2	20
3R. =	1	0	0
26P. =	0	0	26
	221	0	26 Ans.

2. Required the number of acres, &c. statute-measure, in 221A. 0R. 26P. customary.

BY RULE 2.

P.
221 × 120 = 26520
26 = 26
160)26546(165
160
1054
960
946
800
40)146(3
120
26 Ans. 165A. 3R. 26P.

3. In 265A. 2R. 24P. statute, how many acres, &c. customary measure?

Ans. 354A. 0R. 24P.

GENERAL RULES

For constructing the foregoing Tables, and for finding the Multipliers given in the Notes.

RULE 1.—Divide the number of square feet in an acre, statute-measure, by the number of square feet in an acre, customary-measure, and the quotient will be an acre and decimals, or decimals of an acre. Multiply this quotient by 2, and the product will be the acres and decimals, customary-measure, in 2 acres, statute-measure. Bring the decimals to their proper quantity, and you will have the acres, roods, and perches, customary-measure, in 2 acres, statute-measure. In a similar manner you must proceed with 3 acres, 4 acres, &c.

RULE 2.—Divide the number of square feet in a rood, statute-measure, by the number of square feet in a rood, customary-measure, and the quotient will be a rood and decimals, or decimals of a rood. This quotient being multiplied by 2, the product will be the roods and decimals, customary-measure, in 2 roods, statute-measure. In a similar manner you must proceed with 3 roods.

RULE 3.—Divide the number of square feet in a perch, statute-measure, by the number of square feet in a perch, customary-measure, and the quotient will be a perch and decimals, or decimals of a perch. Multiply this quotient by 2, and the product will be the perches and decimals, customary-measure, in 2 perches, statute-measure. In a similar manner you must proceed with 3 perches, 4 perches, &c.

RULE 4.—To find the multipliers given in the notes, say, as the number of square feet in an acre, statute-measure, is to an acre, so is the number of square feet in an acre, customary-measure, to the multiplier.

Or, divide the number of square feet in a perch, customary-measure, by the number of square feet in a perch, statute-measure, and the quotient will be the multiplier.

Note.—Table V. was constructed by Rule 1. given in the last Problem.

REMARKS.

1. IF a tenant rents a farm of 100 acres, reckoning 120 perches to an acre of tenantry measure, which is but 3 roods, statute-measure; he loses 1 acre in 4, or 25 acres in the whole, which reduces his farm to 75 acres, statute-measure.

2. If a tenant takes a farm, in Devonshire or Somersetshire, of 100 acres, at the customary-measure of 15 feet to a perch; he loses nearly 1 statute acre in 6 customary acres, or 17 acres, 1 rood, 17 perches, in the whole, which reduces his farm to 82 acres, 2 roods, 23 perches, statute-measure.

3. If a tenant rents a farm of 100 acres, in Cornwall, at the customary-measure of 18 feet to a perch; he gains about 1 statute acre in 5 customary acres, or 19 acres, 0 roods, 1 perch, in the whole; consequently, his farm contains 119 acres, 0 roods, 1 perch, statute-measure.

4. If a tenant takes a farm of 100 acres, in Lancashire, reckoning 21 feet to a perch, customary-measure; he gains

nearly 2 statute acres in three customary acres, or 61 acres, 3 roods, 37 perches, in the whole; hence, his farm contains 161 acres, 3 roods, 37 perches, statute-measure.

5. If a tenant rents a farm of 100 acres, in Cheshire or Staffordshire, reckoning 24 feet to a perch, customary-measure; he gains nearly 16 statute acres in fourteen customary acres; or 111 acres, 2 roods, 11 perches, in the whole; hence, his farm contains 211 acres, 2 roods, 11 perches, statute-measure.

6. Three acres, statute-measure, are equal to 4 acres, Wiltshire measure.—Five acres, statute-measure, are equal to 6a. 0r. 8p. Devonshire and Somersetshire measure.—Six acres, statute-measure, are equal to 5a. 0r. 6½p. Cornwall measure.—Five acres, statute-measure, are equal to 3a. 0r. 14p. Lancashire measure.—Thirty acres, statute-measure, are equal to 14a. 0r. 28½p. Cheshire measure.

SCOTCH MEASURE.

In Scotland, land is generally measured by a chain of 74 feet in length, which is divided into 100 equal links, the same as the English chain.

The area is given in acres, roods, and falls; 342.25 square feet making 1 fall, 40 falls 1 rood, and 4 roods 1 acre.

TABLE VI.

A Table of Scotch Lineal Measures.

Inches.						
8.88	1 Lk.					
12	1.35	1 Foot.				
37	4.16	3.08	1 Ell.			
222	25	18.5	6	1 Rd.		
88.8	100	74	24	4	1 Chain.	
71040	8000	5920	1920	320	80	1 Mile.

Note.—It appears by comparing the above Table with that given in Part III., that the Scotch ell is 1 inch more than the English yard; and the Scotch mile 640 feet more than the English mile; but by a statute of James II, it was enacted that the Scotch mile, like the English, should contain 1760 yards.

TABLE VII.

A Table of Scotch Square Measures.

Sq. Inches.						
78.8544	1 Sq. Lk.					
144	1.82	1 Sq. Ft.				
1369	17.36	9.51	1 S. Ell.			
49284	625	342.25	36	1 S. Fall.		
1971360	25000	13690	1440	40	1 S. Rd.	
7885440	100000	54760	5760	160	4	1 S. Acre.

Note.—By comparing the above Table with that given in Part III., we find that the Scotch fall contains 70 square feet more than the English statute perch; and the Scotch acre 11200 square feet more than the English statute acre; hence 1089 Scotch acres are equal to 1369 English acres.

TABLE VIII.

A Table for reducing English to Scotch Measure.

Eng. Acs.	Scotch. A.	R.	F.
1	0	3	7.3
2	1	2	14.5
3	2	1	21.8
4	3	0	29.1
5	3	3	36.4
6	4	3	3.7
7	5	2	10.9
8	6	1	18.2
9	7	0	25.5
10	7	3	32.8
20	15	3	25.5
30	23	3	18.3
40	31	3	11.0
50	39	3	3.8
100	79	2	7.5

Eng. Rds.	Scotch R.	F.
1	0	31.8
2	1	23.6
3	2	15.5

Eng. P.	Scotch. Falls.	Eng. P.	Scotch. Falls.
1	0.8	21	16.8
2	1.6	22	17.5
3	2.4	23	18.3
4	3.2	24	19.1
5	4.0	25	20.0
6	4.8	26	20.8
7	5.6	27	21.5
8	6.4	28	22.3
9	7.2	29	23.1
10	8.0	30	24.0
11	8.8	31	24.8
12	9.6	32	25.4
13	10.3	33	26.2
14	11.1	34	27.0
15	12.0	35	27.8
16	12.8	36	28.6
17	13.5	37	29.4
18	14.3	38	30.2
19	15.1	39	31.0
20	16.0		

Note 1.—The General Rules given in the beginning of this Section, may be applied in reducing English to Scotch, or Scotch to English measure.

2.—Scotch measure may also be reduced to English statute-measure, by multiplying the number of square links, Scotch measure, by 1.2571 and the product will be the answer in square links.

EXAMPLES.

1. In 45A. 2R. 23P. English statute-measure, how much Scotch measure?

BY RULE I.

```
      A.  R.  P.
      45  2   23
       4
     ----
     182
      40
     ----
    7303
  272.25 = 16.5 × 16.5
  ------
   36515
  14606
 14606
51121
14606            4,0
------------------------
342.25)1988241.75|580,9.3
       171125   4|145 9.3
       ------    -------------------
       276991     36A. 1R. 9.3F. Ans.
       273800     ===================
       ------
       ..319175
         308025
         ------
         .111500
          102675
          ------
          ..8825
          ======
```

BY TABLE VIII.

	A.	R.	F.
40A. =	31	3	11
5A. =	3	3	36.4
2R. =	0	1	23.6
23P. =	0	0	18.3
	36	1	9.3 Ans.

2. In 36A. 1R. 9.3F. Scotch measure, how much English measure?

BY RULE 2.

```
            A.  R.  P.
            36  1   9.3
             4
           ---
           145
            40
         -------
          5809.3
          342.25
         -------
         290465
        116186
       116186
      232372
     174279              4,0
272.25)1988232.925|730,2.9
     190575      4|182  22.9
     ------        ------------
     ..82482        45A. 2R. 22.9P. Ans
       81675        ============
       ------
       ..80792
         54450
         ------
         263425
          245025
         -------
         . 18400
         =======
```

BY NOTE 2.

```
   30A. = 3000000
    6A. =  600000
    1R. =   25000
    9P. =    5625
 3/10P. =     187.5
        -----------
         3630812.5
            1.2571
        -----------
         36308125
        254156875
       181540625
      72616250
     36308125
   --------------
   45.64294.39375
            4
   --------------
   2.57176
         40
   --------------
   22.87040 Ans. 45A. 2R. 22.8P.
   ========
```

3. Reduce 102A. 3R. 38P. of English statute-measure, to Scotch measure. Ans. 81A. 3R. 27.7F.

4. In 52A. 2R. 36F. Scotch measure, how many acres, &c. English measure? Ans. 66A. 1R. 5P.

IRISH MEASURE.

In Ireland, land is measured by a chain of 84 feet in length, which is divided into 100 equal links, the same as the English chain.

The area is given in acres, roods, and perches, the same as in England; but the Irish perch contains 168.75 square feet more than the English perch; and 98.75 square feet more than the Scotch fall; consequently, the Irish measure is greater than either the English or the Scotch measure.

TABLE IX.

A Table of Irish Lineal Measures

Inches.						
10.08	1 Link.					
12	1.19	1 Ft.				
36	3.57	3	1 Yd.			
252	25	21	7	1 Pch.		
1008	100	84	28	4	1 Chn.	
80640	8000	6720	2240	320	80	1 Mile.

Note.—By comparing the above Table with that given in Part III., we find that the Irish mile is 480 yards more than the English mile; hence 11 Irish miles are equal to 14 English miles.

TABLE X.

A Table of Irish Square Measures.

Sq. Inches.						
101.6064	1 Sq. Lk.					
144	1.42	1 Sq. Ft.				
1296	12.78	9	1 S.Yd.			
63504	625	441	49	1 S. Ph.		
2540160	25000	17640	1960	40	1 S.Rd.	
10160640	100000	70560	7840	160	4	1 S. Ac.

Note 1.—By comparing the above Table with that given in Part III., we find that the Irish perch contains 168.75 square feet more than the English statute perch; and the Irish acre 3000 square yards more than the English acre; hence 121 Irish acres are equal to 196 English acres.

2.—Irish measure may be reduced to English, or English measure to Irish, by Problem III.

3.—Scotch measure may be reduced to Irish, or Irish measure to Scotch, by the following rule: As the square feet in a square perch of the required measure, is to the given area in perches; so is the square feet in a square perch of the given measure, to the required area in perches.

4.—The rule given in the last note, is the substance of the two General Rules given in the beginning of this Section; and will hold good for all kinds of measures.

The Rules given in this Work, for finding the Areas of Figures, and Dividing Land, are applicable in all cases of Land-Surveying.

As both the Scotch and Irish chains are divided into 100 equal parts, the same as the English chain; it is manifest that the Rules given in this Work, for finding the areas of figures, and for laying out, parting-off, and dividing land, are applicable in all cases of Surveying, whether the dimensions be taken with the English, Scotch, or Irish chain.

They also hold equally true, if the dimensions be taken in yards, tenths and hundredths; in feet and tenths; or in any other denominations.

EXAMPLES

IN

ENGLISH, SCOTCH, AND IRISH MEASURES.

1. The base of a triangular field, measured by the English chain, is found to be 1252 links, and the perpendicular 684 links; what is the area of the field, in statute-measure?

links.
1252
684
5008
10016
7512
2)856368
4.28184
4
1.12736
40
5.09440 Ans. 4A. 1R. 5P.

2. Reduce 4A. 1R. 5P. English measure, to Scotch and Irish measure.

Reduced to Scotch Measure by Table VIII.

	A.	R.	F.
4A. =	3	0	29.1
1R. =	0	0	31.8
5P. =	0	0	4.0
	3	1	24.9 Ans.

Reduced to Irish Measure, by Table III.

	A.	R.	P.
4A. =	2	1	35.0
1R. =	0	0	24.7
5P. =	0	0	3.0
	2	2	22.7 Ans.

3. The base of a triangular field, measured by the Scotch chain, is 1252 links, and the perpendicular 684 links; required the area of the field in Scotch measure.

links.
1252
684
5008
10016
7512
2)856368
4.28184
4
1.12736
40
5.09440 Ans. 4A. 1R. 5P.

Note.—Here the area is the same as that found in the first example.

4. Reduce 4A. 1R. 5F. Scotch measure, to English and Irish measure.

Reduce to English Measure by Note 2, under Table VIII.

sq. links.
4A. = 400000
1R. = 25000
5F. = 3125
428125
1.2571
428125
2996875
2140625
856250
428125
5.38195.9375
4
1.52780
40
21.11200 Ans. 5A. 1R. 21.1P.

Reduced to Irish Measure by Note 3, under Table X.

```
                     A.  R.  P.
                     4 . 1   5
                     4
                    ---
                    17
                    40
     sq. ft.                   sq. ft.
   As 441       :   685   ::   342.25
                 342.25
                 ------
                   3425
                  1370
                 1370
                2740
               2055          4,0
          441)234441.25|53,1.61
              2205    4|13   16,1
              .1394      3A. 1R. 16.1P. Ans.
               1323
               ..711
                 441
                2702
                2646
                ..565
                  441
                  124
```

5. The base of a triangular field, measured by the Irish chain, is 1252 links, and the perpendicular 684 links; what is the area of the field in Irish measure?

```
            links.
            1252
             684
            ----
            5008
          10016
          7512
        2)856368
         4.28184
               4
         -------
         1.12736
              40
         -------
         5.09440 Ans. 4A. 1R. 5P.
```

Note.—Here the area is the same as that found in the first and third examples, which proves that the Rules for finding the areas of figures hold good for all kinds of measures.

6. Reduce 4A. 1R. 5P. Irish measure, to English and Scotch measure.

Reduced to English Measure by Note 3, under Table X.

```
                     A.  R.  P.
                     4   1   5
                     4
                    ---
                    17
     sq. ft.        40         sq. ft.
   As 272.25   :   ---    ::    441
                   685
                   441
                   ---
                   685
                  2740
                 2740      4,0
        272.25)302085  |11,09.5
               27225  4| 27   29.5
                29835    6A. 3R. 29.5P. Ans.
                27225
                 261000
                 245025
                  159750
                  136125
                  . 23625
```

Reduced to Scotch Measure by Note 3, under Table X.

```
        sq. ft.       sq. p.       sq. ft.
     As 342.25    :    685    ::    441
                       441
                       685
                      2740
                     2740      40,
           342.25)302085  |88,2.6
                  273800 4|22   2.6
                 .282850    5A. 2R. 2.6P. Ans.
                  273800
                  ..90500
                    68450
                   220500
                   215350
                   ..5150
```

7. The length of a rectangular field, measured by the English chain, is 1435 links, and its breadth 923 links; required the area of the field, in English, Scotch, and Irish measure.

Ans. 13A. 0R. 39P. English measure; 10A. 2R. 5.6P. Scotch measure; and 8A. 0R. 28P. Irish measure.

8. A Land-Surveyor is required to measure a triangular field, and to return the area in English statute-measure; but not having an English chain, he found the base of the field to measure 1548 links, and the perpendicular 924 links, by a Scotch chain; required the area of the field in English statute-measure. Ans. 8A. 3R. 38.4P.

GAD MEASURE.

In some places the dimensions of land are taken, by farmers, workmen, &c. with a pole or staff of 8, 9, or 10 feet in length, called a Gad; hence the square gad of 8 feet, contains 64 square feet; the square gad of 9 feet, 81 square feet; and the square gad of 10 feet, 100 square feet.

When the area of a piece of land is wanted in gad-measure, the dimensions, taken in gads and feet, must be brought into feet; from which the area, in square feet, may be obtained, by the rules already given. Divide this area by 64, 81, or 100, respectively; and the quotient will be the number of square gads; and the remainder will be square feet. If the remainder be multiplied by 4, and divided as before, the quotient will be $\frac{1}{4}$, $\frac{1}{2}$, or $\frac{3}{4}$ of a gad.

If, however, the gad be decimally divided, the dimensions will be taken in gads and tenths, and the rules will then give the area, in square gads and decimal parts.

The decimals may be reduced to their proper quantity by multiplying them by the number of square feet in a gad; or to quarters of a gad, by multiplying them by 4, as before directed.

Note 1.—Gad-measure may be reduced to English statute-measure, by the following Rule: As 272.25, the square feet in a square perch, statute-measure, is to the given area in gads; so is the square feet in a gad of the given measure, to the required area in perches. Or, divide the square feet in the given area, by 272.25; and the quotient will be the answer in square perches, statute-measure.

2.—To reduce statute-measure to gad-measure, divide the given area in square feet, by the number of square feet in a gad; and the quotient will be the answer in square gads.

EXAMPLES.

1. The length of a rectangular piece of land, measured with the eight-feet gad, is 45 gads, 5 feet; and its breadth 21 gads, 3 feet; required its area in square gads.

```
                   G.   F.         G.   F.
                   45   5          21   3
                    8               8
                  ----            ----
                  365              171
                  171
                  ----
                  365
                2555
                365
8 × 8 = 64)62415(975G. 15F. Ans.
                576
               -----
                481
                448
               -----
                 335
                 320
                 ---
                . 15 rem.
```

2. The area of a piece of ground, measured by the eight-feet gad, is found to be 975 gads, 15 feet; required its area in statute-measure?

BY NOTE 1.

```
                 G.   F.
                 975  15
                  64
                ----
                3905
              5851       4,0
      272.25)62415.00 22,9.25
             54450  4| 5  29¼
             -----   ---------------
              79650   1A. 1R. 29¼P. Ans.
              54450
              ------
              252000
              245025
              ------
               69750
               54450
               ------
               153000
               136125
               ------
               . 16875 rem.
```

3. The area of a piece of land is 1A. 1R. 29¼P. statute-measure; what will be its area in square gads, if it be measured by the eight-feet gad?

BY NOTE 2.

```
A.  R.  P.
1   1   29.25
4
―――
5
40
―――――
229.25
272.25
――――――
114625
 45850
  45850
  160475
   45850
―――――――――――――
64)62413.3125(975G. 13.3F. Ans.
   576
   ―――
    481
    448
    ―――
     333
     320
     ―――
     13.3 rem.
```

4. The base of a triangular field, measured with the nine-feet gad, decimally divided, is 58.7 gads, and the perpendicular 26.9 gads; required the area of the field, in gad, and also in statute-measure?

Here, $58.7\times26.9=1579.03$; and $\frac{1579.03}{2}=789.515$, the area in gads; and by Note 1, as 272.25 feet : 789.515 gads :: 81 feet : 234.89 perches = 1A. 1R. 34.89P. the area in statute-measure.

5. The length of eight lands, forming a furlong in an open field, is found, by the ten-feet gad, to be 118.7 gads, and their breadth 12.4 gads; what is the area of the furlong?

Ans. 1471.88 gads = 3A. 1R. 20.6P. statute-measure.

6. The diagonal of a trapezium measures 56.2 gads, by the

ten-feet gad, one of the perpendiculars 21.4 gads, and the other 18.3 gads; required the area of the trapezium?

Ans. 1115.57 gads = 2A. 2R. 9.7P. statute-measure.

ESTIMATING LAND BY THE MILE.

The Method of making a rough Calculation of the Number of Acres contained in a Common, Moor, Lordship, County, or Kingdom.

Endeavour to ascertain, in miles, as nearly as you can, either by your own observation, or from the information of others, the mean length and breadth of the land to be estimated; then multiply the length by the breadth, and the product will be the area in square miles. Multiply this area by 640, the number of acres in a square mile; and the product thus obtained will be the area in acres, according to this method of calculating.

Note 1.—The mean length and breadth of a county or a kingdom, may be found from a map, in the following manner: Measure several lengths, by the scale of miles, upon the map; add them together; and divide their sum by their number, for a mean length. A mean breadth may be obtained by a similar process.

2.—The foregoing method of finding the area of counties and kingdoms must of course, be liable to considerable inaccuracy, not only as regards the method of taking the dimensions, but also as respects the correctness of the map and scale; for it is evident that if these be not truly delineated, the dimensions can never be obtained to any degree of accuracy.

3.—When you have a correct map and scale of a county or a kingdom, its content may be found to a considerable degree of accuracy by the following method: Divide the map into triangles and trapeziums in the most convenient manner; and straighten the crooked shores or coasts, either with a lantern horn, as directed in Part IV., or by the parallel ruler, as directed in Part V. Measure the bases, diagonals. and perpendiculars correctly, by the scale of miles belonging to the map; find the area of each figure separately; and the sum of these areas will be the whole area required.

EXAMPLES.

1. Suppose the mean length of a common or moor be estimated at $3\frac{3}{4}$ miles, and its mean breadth at $2\frac{1}{4}$ miles; what is the area in acres, according to this estimation?

miles.
3.75
2.25
1875
750
750
8.4375 miles.
640
3375000
506250
5400.0000 acres.

Ans. 5400 acres.

2. If the mean length of a lordship be estimated at $4\frac{1}{4}$ miles, and its mean breadth at $2\frac{1}{2}$ miles; what is the content in miles and acres? Ans. 10.625 miles, and 6800 acres.

3. The mean length of a county, found from a map, is 63 miles, and its mean breadth 42 miles; what is its area in miles and acres? Ans. 2646 miles, and 1693440 acres.

4. Mr. Pinkerton says, in his Geography, that the content of Ireland is computed at 27457 square miles; what is its area in acres? Ans. 17,572,480 acres.

5. According to Mr. Pinkerton, the content of Scotland is computed at 27793 square miles; required its area in acres. Ans. 17,787,520 acres.

6. The same author observes, that the extent of England and Wales is computed at 58335 square miles; what is the area in acres? Ans. 37,334,400 acres.

Note.—The real quantity of land in England is very uncertain; and different writers have given very different statements. Dr. Greve, in the Philosophical Transactions, No. 330, states the number of acres in England at 46,000,000; but Sir William Petty, in his Political Arithmetic, states them at no more than 39,000,000. Dr. Halley's statement is also 39,000,000 acres; but Zimmerman's statement, in his Political Survey, is only 34,631,680. Dr. Grew's statement stands at 46,800,000; and in the Gentleman's Magazine, for July, 1804, is a statement made from Smith's County Maps, by which the area is estimated at 32,134,400 acres.

Now, if we take this number from the area of England and Wales, found in the last example, we shall have 5,200,000 acres for the area of Wales.

LAND-SURVEYING.

Part the Seventh.

The Method of Measuring and Planning Villages, Towns, and Cities; Directions for Measuring and Planning Building Ground, and Dividing it into convenient Lots for Sale; and Miscellaneous Questions relating to Surveying, Laying-out, Parting-off, and Dividing Land.

SECTION I.

THE METHOD OF MEASURING AND PLANNING VILLAGES, TOWNS, AND CITIES.

As villages, towns, or cities, present themselves in almost every extensive survey, and are generally measured and planned with the adjoining or surrounding lands, it is highly necessary that something should be said on the method of taking and laying down the dimensions of such places, and finishing the plans.

Besides, the plans of towns and cities are so essentially necessary for the purposes of commercial and general reference, that Surveyors are not unfrequently employed in forming correct drawings of the same, in order to have them engraved and published in copperplates.

Without this art, we could not obtain the ichnography of towns and cities; neither could we have any just idea of the shape, extent, and direction of the streets; the size and number of the public buildings; the local conveniences enjoyed by the inhabitants, &c. &c. of those places which circumstances will not permit us to visit.

Directions for taking the Dimensions of Villages, Towns, and Cities.

The dimensions of villages, towns, and cities, may generally be obtained by the chain only; as the streets are usually wide enough to admit of angles or tie-lines being taken with the chain, at the meetings or intersections of the streets, in the same manner as directed in Problems 4 and 5, Part IV. In these Problems the methods of measuring meres, woods, roads, rivers, and canals, are clearly illustrated and exemplified; and if the learner make himself completely master of those departments of Surveying, any difficulties which may present themselves in measuring villages, towns, or cities, will be easily surmounted.

It will sometimes happen that the tie-lines cannot be measured at a greater distance from the angular points than 30 or 40 links. In such cases, the tie-lines must be taken to a quarter of a link, and both them and the angular distances must be multiplied by 2, 3, 4, or any larger number, as circumstances may require; and the products used in laying down the chain-lines. (See Prob. 2, Part IV.)

The notes taken in measuring towns and cities must be entered precisely in the same manner as in surveying estates; and in measuring along the streets, offsets must be taken to the houses on both sides of the chain-line; and particularly to every corner and projection; even the small projections of bow-windows must not be omitted.

Sketches of the bases of the buildings, particularly the corners and projections, must be made in the margin of the note-book, in order to assist the Surveyor in drawing a correct plan.

All public buildings, such as churches, prisons, castles, court-houses, market-places, halls, colleges, mansion-houses, &c. &c. must be distinctly noticed; and the range of the first line should be taken with the compass, in order that the Draftsman may be able to lay down every street in its true direction.

Note 1.—In measuring along the streets, all the offsets to the buildings must be taken at right-angles to the chain-lines. The bases of the buildings, and all the projections must be sketched, as you proceed; and the breadths of the buildings, the lengths and breadths of the projections, &c. &c. must be correctly measured, and entered opposite to those parts of the sketch to which they respectively belong. The sign + (plus) is usually placed between the breadth of a building, at its perpendicular distance from the chain-line. The method of sketching the bases of buildings, and entering the notes, is exemplified in pages 4, 10, and 12, of the engraven Field-book, to which the learner is referred.

2.—When a town and the surrounding or adjoining lands are both to be measured and planned together, the dimensions must be taken with Gunter's chain; and the lines measured along the streets must be properly connected with those measured in surveying the adjoining estates; but if the plan of a town only is required, it is more convenient to take the dimensions with a chain of 50 feet in length, divided into 50 links, and an offset staff of 10 feet in length.

3.—As station staves cannot be fixed in the streets, in consequence of the pavement, they must either be set in wooden pedestals, made for that purpose, or two or more assistants must each hold a staff in those places that are pointed out by the Surveyor.

4.—Sometimes it is most convenient to measure external or main-lines, on the outside of the town, as in surveying a mere or wood, Prob. 4, Part IV.; and in running such lines, stations must be left at the ends of the streets, as you pass them, in order that lines may be run from one station to another in measuring the streets.

5.—In some situations, and under certain circumstances, it is most eligible to measure the first line along one of the principal streets; and to intersect this line by another, measured along some other principal street, nearly at right-angles with the former; then these two lines being tied together by a connecting line, measured in the most convenient manner, will divide the town into four parts, each of which may be measured separately, by running lines in the most advantageous manner. (See a similar remark in Note 5, Method I. Part V.)

6.—In putting down stations at the ends of the streets, &c. the number of the station may be made upon the wall of the opposite building, (if there be one,) with red or white chalk, in such a situation that an offset may be taken, at right-angles to the building, from the station marked upon the wall, to the station on the chain-line. This offset being entered in the book, and again measured from the station on the wall, at right-angles to the building, will give you the station on the chain-line, whenever you may want to find it.

7.—When the foregoing method cannot be adopted in consequence of not being able to take a right-angled offset from any building to the station which you wish to fix, then two lines may be measured from the station to the corners, or to any other parts of two adjoining buildings; and the intersection of these lines, when measured from the buildings, will give the station required.

8.—After all the principal streets have been measured, then proceed to the smaller and intermediate streets; and lastly to the lanes, alleys, courts, yards, and every other part which it may be thought necessary to represent upon the plan.

9.—When any of the streets are so narrow as not to admit of tie-lines being taken with the chain, the angles which the chain-lines make with each other, at the meetings or intersections of the streets, must be taken in degrees and minutes, by a theodolite; and in planning, they must be laid down as directed in Problems 20 and 21, Part I. (See the Description of the Theodolite, page 374.)

10.—What has been advanced on this subject will, no doubt, be acceptable to learners; but as towns are built after such a variety of plans, and consequently vary so much in their forms, no directions can be given that will be applicable to every particular case to be met with in practice. A great deal will always depend upon the skill and judgment of the Surveyor, who should, after duly examining every part of the town, endeavour to run his lines in the most advantageous manner.

EXAMPLE.

Let it be required to measure the New Town, No. 7, Plate VII.

In order to follow the method described in Note 4, we shall begin at the south-west corner, as in Problem 4, Part IV.; although the survey would be conducted precisely in the same manner, if we begun at any other corner.

First Line. Put down + 1, at the S. W. corner, and proceed towards the S. E. corner; taking offsets to the buildings, wherever it is necessary; and sketching their bases in the margin of the note-book. At the end of High Street, put down + 2; at Queen Street, + 3; at Low Street, + 4; at the S. E. corner, + 5; and produce the line at pleasure, to + 6.

Second Line. From + 5, proceed towards the N. W. corner; but when you arrive at the end of York Street, put down + 7; and thence run a tie-line to + 6. From + 7, proceed with the main-line; and at King Street, put down + 8; at George Street, + 9; at the N. W. corner, + 10; and continue the line to + 11.

Third Line. From + 10, go towards the N. W. corner; but when you come to the end of Low Street, put down + 12, from which run a tie-line to + 11. Proceed from + 12; and at the end of Queen Street, put down + 13; at High Street, + 14; and at the N. W. corner, + 15.

Fourth Line. From + 15, proceed towards the S. W. corner; and at the end of George Street, put down + 16; at King Street, + 17; at York Street, + 18; and continuing the line to + 1, you will have circumscribed the town with four main-lines, into which the lines measured along the streets must be run.

Note.—After the first three lines are laid down, it is evident that the fourth line will serve as a check; and will reach exactly from + 15 to + 1, if all the operations have been conducted with accuracy.

Fifth Line. From + 18, through York Street, to + 7.

Sixth Line. From + 8, along King Street, to + 17.

Seventh Line. From + 16, through George Street, to + 9.

Eighth Line. From + 12, along Low Street, to + 4.

Ninth Line. From + 3, through Queen Street, to + 13.

Tenth Line. From + 14, along High Street, to + 2; thus the survey of the town is completed.

Note 1.—The chain-lines and stations do not appear upon the plan, as they could not have been conveniently entered without increasing its size; the learner will, however, find no difficulty in making a similar plan, two or three times as large; drawing the chain-lines, and putting down the stations in their proper places. Or he may take the dimensions of the given plan with a small scale; enter them in a note-book; and then draw a rough plan by a larger scale, and after that a finished one, which will be an exercise that will tend much to his improvement.

2.—The survey of this town might have been carried on according to the directions given in Note 5, by measuring a line through King Street, and another through Queen Street; and then connecting these two lines together by tie-lines taken at the point of intersection. Thus would the town be divided into four parts, each of which might be measured separately.

3.—Here it will be proper to observe, that in taking an angle with the chain or theodolite, at the intersection or meeting of two lines, either the external or internal angle may be taken, as circumstances may make it most convenient; but it should always be remembered, that neither very acute, nor very obtuse angles should be measured, if it can be avoided, as both are liable to errors, in laying down. Those angles which approach nearest to right-angles should always be preferred, as being most correct.

4.—By way of proof, it is an excellent plan to take both the angles. If they be taken by the chain, you will have a check-line, by the scale; and if taken by the theodolite, their sum should be 180 degrees; and you will also have a proof in planning, in consequence of having measured an angle and its supplement. (See Definition 16, and Problems 20 and 21, Part I.)

A Description of the Theodolite.

"The theodolite is a mathematical instrument used by Surveyors, for taking horizontal-angles, in measuring meres, woods, roads, rivers, canals, villages, towns, cities, &c. &c. when tie-lines cannot be taken by the chain, in consequence of obstructions. It also enables us to take such angles as are necessary for calculating the heights and distances of remote objects by plane trigonometry.

There are various forms of this instrument, arising from the successive improvements of many eminent artists; but the principle of its operation is the same in all, whatever difference may appear in the construction.

A theodolite of the best kind consists of the following principal parts:

1. A telescope to direct the sight, and enable the operator to distinguish objects at a distance. To the telescope is attached a sperit-level, to assist the operator in placing the instrument in a horizontal position.

2. A vertical arc for taking angles of altitude and depression.

One side of this arc is graduated to every half degree; and these are again subdivided to every minute of a degree by the index or nonius. This side is numbered from 0 to 90 degrees, towards the eye-end, for angles of altitude; and from 0 to 50 degrees, towards the object-end, for angles of depression.

The other side of the vertical arc contains a line of divisions, showing the number of links to be deducted from each chain's length, in measuring up or down any ascent or descent, in order to reduce it to a true horizontal line, according to the directions given for surveying hilly ground, Method I, Part IV.

3. A horizontal limb and compass, for taking horizontal-angles, and the bearings of objects.

The horizontal limb consists of two circular plates, one movable on the other; and the outer edge of the upper plate contains an index to the degrees and minutes on the lower plate. The upper plate, together with the compass, vertical arc, telescope, and level, are easily turned round upon a centre.

The lower plate of the horizontal limb, is divided to half degrees; and these are again subdivided, by the scale of the nonius, to every minute of a degree.

This limb is numbered from the right-hand towards the left, with 10, 20, 30, 40, &c. to 360 degrees.

4. The whole instrument fits on the conical ferril of a strong, brass-headed staff, with three substantial wooden legs, by which it can be firmly fixed upon the ground.

The top or head of the staff consists of two brass plates, parallel to each other; and four screws pass through the upper plate, and rest upon the lower plate. By the action of these screws, the situation of the upper plate may be varied, so as to set the horizontal limb truly level, or in a plane parallel to the horizon.

Note 1.—The compass is fixed on the upper plate of the horizontal limb; and the ring of the compass is divided into 360 degrees, which are numbered in a direction contrary to those on the horizontal limb. The bottom of the compass-box is divided into four parts or quadrants, each of which is subdivided to every 10 degrees; and numbered from the meridian, or north and south points, each way, to the east and west points. In the middle of the box is a steel pin, finely pointed, on which is placed the magnetic needle. The box also contains a small sperit-level, fixed at right-angles to that which is attached to the telescope. By the assistance of these two levels, and the four screws before mentioned, the instrument can be placed in a truly horizontal position. (See the Description of the Compass, Part II.)

2.—The method of using the theodolite may soon be acquired by a little practice in the field; but it will be obtained still more easily if the learner be assisted by the instructions of a practical operator.

3.—When trigonometrical calculations are to be made from the angles, they should, if possible, be taken to a minute; but an instrument that will take an angle to five minutes will answer very well for a practical Surveyor; as angles cannot be laid down nearer, either by the line of chords or the protractor.

4.—In order to lay down an angle by the protractor, draw a line at pleasure, for one side of the angle; apply the diameter of the instrument to this line, and its centre to the point where the angle is to be made; mark the point under the given degree, and through this point draw the other side of the angle.

5.—To measure a given angle by the protractor, apply the diameter to one side, and the centre to the angular point; and the degree of the limb under which the other side passes, is the measure of the angle, (See Problems 19, 20, 21, 22, and 23, Part I.)

6.—The following prices stand in Mr. Jones's Catalogue, for theodolites of different kinds; viz. a common theodolite, without rack-work, the horizontal limb six inches in diameter, eight guineas. Ditto, with rack-work movements, and which will take angles to two minutes of a degree, twelve guineas. Second best 7 or 8-inch theodolites, which will take angles to a minute, sixteen guineas, and £2[illegible] : 1s. Very best improved ditto, £33 : 12s. Eight-inch ditto, £37 : 16s. Nine-inch ditto, £42.

Directions for Planning Villages, Towns, and Cities.

All the main-lines must first be laid down; and the stations upon them marked off. The lines measured along the streets must then be drawn; and the stations upon them denoted. The bases of the buildings must next be laid down from the offsets, so as to form the streets; and shaded as directed in Part V., and exhibited in Plate VII. The rough plan must then be transferred to a clean sheet, by some of the methods described in Part V., in order to make a finished plan.

The bases of all public buildings, such as churches, castles, prisons, session-houses, market-places, infirmaries, hospitals, mansion-houses, monuments, &c. &c. should be delineated upon the plan with the utmost correctness; and most Surveyors draw the bases of the columns which support the roofs of market-crosses, the galleries of churches, &c. &c. as exhibited in the plate to which we last referred.

The streets are usually left white; but some draftsmen prefer colouring the causeways, with a tint of blue, to distinguish them from the carriage-roads, which are generally washed with a yellowish brown.

The grass-plots, in gardens, public squares, &c. &c. whether they be rectangles, rhombuses, circles, ovals, or regular polygons, should be correctly delineated upon the plan; then shaded with Indian ink, and washed with green, in the same manner as pasture-grounds; and trees, water, pleasure-grounds, gardens, gravel-walks, &c. &c. must be shaded and coloured as directed in Part V.

The name of the village, town, or city, should be given in conspicuous characters, in some vacant part of the plan or map; and the names of all the streets, public squares, churches, colleges, halls, prisons, castles, court-houses, mansion-houses, market-places, lanes, alleys, courts, yards, &c. &c. must be entered in their respective situations, in the manner exhibited in Plate VII.

Note 1.—If the dimensions be taken and laid down in feet, a scale of feet must be given; if in yards, a scale of yards must be given; if in chains and links, a scale of chains and links must be given; and if the town or city be very large, a scale of miles and furlongs may be given upon the plan, for the purpose of measuring distances; and as 220 yards make a furlong, the distance of one place from another may be easily obtained in miles and yards.

2.—Any remarks or explanations that it may be thought necessary to give, may be entered in some vacant corner of the plan.

3.—All plans, ornaments, &c. should first be drawn in pencil; and it will tend much to the improvement of the learner, if he form all his printing, German text, and large-hand letters by the pencil also, and then finish them with Indian ink.

4.—In forming letters, ornaments, &c. with the pencil, the lines and strokes should be made as fine as possible; as the ink frequently runs upon the lead, when the pencil has been used too freely; hence the necessity of applying Indian rubber after the outlines have been finely drawn with Indian ink, in order to remove the lead which is not covered by the ink, before we proceed to finish the letters, ornaments, &c.

5.—If the pupil does not succeed well in his first attempt with the pencil, the letters, ornaments, &c. must be effaced with Indian rubber; and he must repeat the process until he can form all the letters, devices, &c. correctly. (See Note 6, Page 250.)

6.—Brookman and Langdon's prepared lead pencils, marked F, for fine drawing, will be found to answer well in making letters, ornaments, &c.; as they are of a middling degree of hardness; consequently the marks made by them may be easily effaced. (See Note 4, page 209.)

7.—After practice has made the learner a proficient in penmanship, he will be able to print, text, and write more expeditiously, without the use of the pencil.

8.—Here it may not be improper to caution the learner against a very common fault of young draftsmen; namely, that of making their lines and letters too strong, both with pencil and ink. The lines, dots, and letters belonging to wooden cuts should never be imitated by the learner, as they are mostly too *strong* and *rough*; but he should take for his pattern the specimens exhibited in the different copperplates, given in this Work.

9.—In Part the Second, ivory plotting-scales are recommended, as being the best; but it may be proper to observe that very good feather-edged plotting scales are now made of box, by most mathematical instrument-makers, which will do very well for school-boys. A twelve-inch box scale may be had for about four shillings; but an ivory scale of the same length, costs ten or twelve shillings, accordingly as it is finished.

10.—What has been said on the subject of planning villages, towns, and cities, will be further illustrated by examining the plan of some large village, town, or city. The author recommends to those who desire to increase their information on this subject, a small plan of Leeds, neatly engraved; and sold by J. Heaton, Leeds, price 2s.; a large, elegant, coloured plan of Leeds, containing all the recent improvements; published by Longman and Co., London, price 21s.; a small plan of London, neatly engraved, price 2s. 6d.; also a new coloured plan of London, with its environs, including the surrounding villages. In this plan all the new roads, streets, buildings, bridges, squares, &c. &c. have been accurately inserted from *original* and *actual* surveys; together with the projected improvements not yet executed. Both these plans are published by Laurie and Whittle, London; the latter on a large sheet, price 6s. In this plan, the bases of houses are shaded with dots, in imitation of sand, as in the lower part of No. 2; but the bases of public buildings are shaded with lines, as in No. 7, Plate VII. The plan is surrounded by a border, which is divided into miles; and each mile is subdivided into eight equal parts or furlongs.

Besides the above maps, it may be proper to observe that an excellent coloured plan of London and its vicinity, has lately been published by W. Darton, No. 58, Holborn Hill, London, in one large sheet, price 6s. 6d. A plan of Edinburgh might also be consulted with considerable advantage, by the young Surveyor; as the new town is laid out with remarkable regularity and elegance.

TO CLEAN PLANS OR MAPS.

It has been intimated to the young draftsman, in Note 6, page 250, that every precaution should be taken to keep plans and maps clean, in executing them: but notwithstanding the greatest possible care be exercised, they will generally be somewhat soiled, (perhaps in consequence of misfortunes,) either by dust, ink, or colours; hence it is necessary to give the method of cleaning them after they are finished.

Note.—Not only the face but also the back of a plan should be cleaned, in order to make it look as well as possible; and give it the appearance of coming from the hands of a neat and elegant draftsman.

To clean Plans or Maps that are soiled with Dust, Indian Ink, or Colours.

Take a sharp penknife, with a roundish point, and scrape those parts gently which are besmeared with ink or colours, until you efface the blots; then use clean Indian rubber freely to those places that are soiled with dust; and lastly, rub the whole map well with white bread; taking care to pare the bread as it accumulates the dust.

Note 1.—Indian rubber is made from the juice of a large and much branched tree, which grows in Guiana, Cayenne, and other parts of South America. The juice is obtained by making incisions through the bark of the tree, chiefly in wet weather. From the wounds thus formed, the juice, which is of a whitish colour, flows abundantly. It is usually brought to Europe in the form of pear-shaped bottles, which are made by spreading the juice over moulds of clay. These exposed to a dense smoke, or to a fire, till they become so dry as not to stick to the fingers; and then by certain instruments of iron or wood, they are ornamented on the outside with various figures. This done, the clay, in the inside, is moistened with water, and then picked out by proper instruments.

2.—When Indian rubber has become foul by frequent use, it may be cleaned by washing it in lukewarm water and soap.

To clean Plans or Maps that are blotted with common Ink.

If the blots be light, they may be scraped out with a penknife, or effaced by rubbing them repeatedly with clean paper wet in water or saliva; but when they are deep, acid or salt of lemons must be used in the following manner: Dissolve a small portion of the acid in hot water, and with a clean hair-pencil, dipped in the solution, wash the blots until they are discharged.

Note 1.—Recent blots are easily obliterated; but when they are old, and very deep, it will be found necessary to let the paper dry, and repeat the wash several times. Salt of lemons is sold in small boxes, by druggists.

2.—When you have to write upon those places from which the blots have been removed, the paper will bear the ink better, if you rub a little pounce upon it, with clean paper; and then smooth it with your folder, or with the haft of your penknife. Sometimes the paper will bear the ink pretty well, after a blot has been removed, by merely smoothing it as above directed.

3.—Pounce or gum sandarach is a resinous gum which exudes from the juniper-tree; and is of a pale yellowish colour. It is imported from the continent in small pieces or tears, about the size of peas; and when reduced to powder, and passed through a fine sieve, it is used for rubbing upon writing-paper, in places where any blot or writing has been scraped out.

4.—Sometimes a spurious kind of pounce is made by reducing resin (the juice of the Scotch fir) to a powder; but this should never be used, as it is too gummy. It may be known from genuine pounce by being of a darker yellow, and having a stronger odour.

5.—Large blots of Indian ink, common ink, or colours may be removed from maps or strong drawing-paper, by washing them repeatedly with a sponge and clear water; always taking care to squeeze and wash the sponge as it absorbs the ink or colours; repeating the process until the blots disappear.

6.—Sponge is a kind of marine, animal production, formed by a species of worms, and found adhering to rocks, shells, &c. chiefly in the Mediterranean sea. The best sponges are those which are white, light, and have the holes small, and near to each other.

7.—Sponge is much used by landscape painters, in washing their pieces with water, after they have finished shading them with neutral tint. This process removes the superabounding shade; discharges the clouds; produces a remarkable softness; and prepares the pieces for taking the colours with ease and freedom.

SECTION II.

DIRECTIONS FOR MEASURING AND PLANNING BUILDING GROUND, AND DIVIDING IT INTO CONVENIENT LOTS FOR SALE.

Directions for Measuring Building Ground.

LAND lying in the vicinity of large towns, is frequently sold by the square yard, for building-ground; and as it always bears a high price when the situation is eligible, it is of the greatest importance, both to the buyer and seller, to ascertain its content with the utmost accuracy.

In order to accomplish this desirable object, the dimensions should be very correctly taken, with a measuring-tape, divided into yards, tenths, and hundredths; or with a tape divided into feet and tenths, or feet and inches.

When the dimensions are taken in feet and inches, the inches must be reduced to the decimal parts of a foot; and the area found from such dimensions, must be divided by 9, to bring it into square yards.

Whatever be the shape of the ground to be measured, it must be divided into such squares, rectangles, trapezoids, trapeziums, or triangles, as will give the true content of the whole; and if the sides be crooked, offsets must be taken as directed in Problem 6, Part III.

Narrow pieces of building-ground must be measured by Problem 7; and if they be very irregular, their areas may be correctly found by the method of equidistant ordinates described in Problem 9, Part III.

Note 1.—As a measuring-tape is not so convenient in taking the dimensions of land as a chain, it is more eligible to use the latter when the land to be measured is extensive; the greatest care, however, must be used in order to obtain the dimensions correctly, which should be taken to a quarter of a link.

2.—The chain must be completely stretched, and held at the bottom of the arrows, in measuring; and if it be an inch or two over long, an allowance must be made in the dimensions: thus, if a line of 650 links be measured by a chain that is 2½ inches above 66 feet, we shall have 6½ × 2½ = 16¼ inches = 2 links *nearly*; hence the true length of the line will be 652 links.

3.—The above method may also be adopted in measuring land, when it is found necessary to correct the dimensions taken by a chain that exceeds the proper length. (See the Description of the Chain, Part II.)

4.—As 4840 square yards make 1 acre, 1210 square yards 1 rood, and 30¼ square yards 1 perch, we can easily reduce acres, roods, and perches to square yards, in the following manner: Multiply 4840 by the number of acres; 1210 by the number of roods; and 30.25 by the number of perches; then the sum of these three products will be the square yards required.

5.—When the area is in square links, divide it by 20.6611, the number of square links in a square yard; and the quotient will be the area in square yards. (See the Table of Square Measures in Part III.)

6.—Building-ground is generally sold in small parcels. Sometimes, however, it is sold by whole fields together, which are afterwards divided by the buyer, and retailed out in small lots.

EXAMPLES.

1. The length of a rectangular piece of building-ground is 65.8 yards, and its breadth 32.6 yards; what is its area in square yards, and its value at 5s. 9d. per square yard?

$$\begin{array}{r l}
\text{Yds.} & \\
65.8 & \\
\underline{32.6} & \\
3948 & \\
1316 & \\
\underline{1974} & \\
\underline{\underline{2145.08}} & \text{Area.}
\end{array}$$

	yd.		s.		yds.		£.	s.	d.	
As	1	:	5.75	::	2145.08	:	616	14	2½	the value.

2. The length of a rectangle measures 85.36, and its breadth 43.28 yards; what is its area in square yards, and its value at 6s. 3d. per square yard?

Ans. The area is 3694.3808 square yards; and the value of the land £1154. 9s. 10½d.

3. The parallel sides of a piece of ground in the form of a trapezoid, measure 84.63, and 72.78 yards, and the perpendicular distance between them 56.59 yards; what is its area in square yards? Ans. 4453.91595 square yards.

4. The diagonal of a trapezium measures 236.5 feet, one of the perpendiculars 189.3 feet, and the other 127.9 feet; what is its area in square yards; and its value at £1. 6s. 6d. per square yard?

Ans. The area is 4167.655 square yards; and the value of the ground £5522. 2s. 10¼d.

5. The base of a triangle measures 369.9 feet, and the perpendicular 234.7 feet; what is its area in square yards, and its value at 2s. 6d. per square yard?

Ans. The area is 4823.085 square yards; and the value £602. 17s. 8½d.

6. The three sides of a triangle measure 362 feet 3 inches, 316 feet 6 inches, and 284 feet 9 inches respectively; what is its area in square yards?

Ans. By Note 4, Part IV., you will find the area to be 4810 square yards.

7. Draw a plan of an irregular piece of land, and find its area in square yards, from the following dimensions, taken in feet.

	A B	
0	1286	145.6
247.6	1015	
	987	59.8
	790	136.5
317.6	720	
	560	164.2
223.5	465	
	346	124.8
345.2	268	
372.4	000	245.3
Begin	at A, and	go West.

Answer.

Double Areas.

359147.3 Offsets on the right.
676164.8 Ditto on the left.
2)1035312.1 Sum.
9)517656.05 Area in square feet.
57517.33 Ditto in square yards.

8. Required the plan of a piece of building-ground, and also its area in square yards, from the following equidistant ordinates, taken in feet.

	A B	
255.8	1000	
250.6	900	
246.3	800	
235.4	700	
221.2	600	
201.9	500	
176.8	400	
168.5	300	
157.7	200	
146.0	100	
139.1	000	
Begin	at A, and	Range East.

Answer.

394.9 The first and last ordinates.
4009.6 Four times the sum, &c.
1604.0 Twice the sum, &c.
6008.5 Sum total.
100 The common distance.
3)600850.0
9)200283.3 Area in square feet.
22253.7 Ditto in square yards.

9. Required the plan of a piece of ground, and likewise its area in square yards, from the following dimensions, taken in feet.

	B C	
0.0	845	
33.2	700	
66.4	600	
74.8	500	
85.6	400	
62.3	300	
50.7	200	
25.9	100	
0.0	000	
	R. off B.	
	A B	
	1253	
	1000	
	586	525.6 C
Begin	at A, and	go West.

Answer.

Double areas.

658576.8 Triangle A B C.
81307.2 Offsets on B C.
2)739884.0
9)369942.0 Area in square feet.
41104.6 Ditto in square yards.

10. Required the plan of a portion of building-ground, and also its area in square yards, from the following dimensions, taken by Gunter's chain; likewise its value, supposing it to have been sold by auction, at 14s. 9d. per square yard.

	B D	
	1235	
	1075	474½ A
C 482½	270	
	R. off B.	
	A B	
22¼	1175	
25½	1100	
45¼	1000	
40½	900	
54¾	800	
68½	700	
70¼	600	
65¾	500	
60¼	400	
55½	300	
40¾	200	
32¼	100	
0	000	
Begin	at A, and	go West.

Note.—In calculating the area, the quarter-links must be treated as decimals.

Answer.

Double Areas.

1181895.00 Trapezium A B C D.
112881.25 Offsets on A B.
2)1294776.25 Sum.
647388.125 Area in square links.

By note 5, we have 647388.125 ÷ 20.6611 = 31333.67, the area in square yards; then, as 1 yd. : 14.75s. :: 31333.67 yds. : 462171.6325s. = 23108£. 11s. 7½d. the value required.

Directions for Planning Building-ground, and Dividing it into convenient Lots for Sale.

Building-ground may be laid down by a plotting-scale, whether the dimensions be taken in yards or in feet, by calling each chain upon the scale, one yard, or one foot, as the case requires; and the intermediate divisions will evidently be tenths of a yard, or tenths of a foot.

If the plot of ground be small, the scale made choice of should be pretty large, so as to make the ground, on the plan, appear to the best advantage; and exhibit every part distinctly.

After the plan has been drawn, the ground must be judiciously divided and laid out, by making streets at a proper distance from each other; and then subdivided into convenient parcels or lots for sale, according to the situation of the place, and the size of the houses for which the ground is best adapted.

Main or principal streets should be much wider than it is necessary to make back or intermediate streets; and the size of house-steads adjoining main streets should exceed the size of those adjoining back streets.

When it is practicable, all streets should be laid out in straight lines; and if possible, their intersections should be always at right-angles to each other; because straight streets are not only more beautiful than crooked ones, but also more commodious for business. Many of our old towns make a wretched appearance in consequence of the crookedness, narrowness, and irregularity of the streets.

Streets are laid out of very different breadths, from 15 to 90 or 100 feet; but when ground is of great value, the breadth of the streets becomes an object of serious consideration, whether the ground, occupied by them, be given by the seller, or purchased by the buyer of the adjoining lots.

Building-ground may sometimes be very elegantly laid out in a square or a rectangle. When this is the case, the houses are built on the margin or outside of the square; and in the middle is left an open area, which is generally ornamented with grass-plots, gravel walks, trees, &c.

If the ground will admit, it is very desirable for each house to have a garden laid out in the front: which must, of course, be sold with the house-stead. The open area may be divided into as many equal parts, as there are house-steads in the square; one part may be sold with each house-stead; and the respective purchasers may occupy the whole as joint property.

Ground laid out in this manner, generally fetches a good price, as most persons think it more pleasant and healthful living in squares than in streets.

After every thing has been properly and judiciously arranged upon the plan, such dimensions must be taken by the scale as will enable the Surveyor to stake out all the streets, squares, lots, house-steads, &c. &c. in the field. This being done, the ground may then be considered as ready for inspection and sale.

Note 1.—House-steads must be laid out of different sizes, according to the respectability of the intended buildings. A room 14 by 15 feet will be found quite large enough for any cottage; and these dimensions may be increased at pleasure, to 20 or 24 feet, according to situation and circumstances.

2.—A plan of ground or buildings, intended for sale, is generally left for inspection, at the office of the surveyor or solicitor, employed on the occasion, from the time of advertising to the time of sale. Also, the special conditions of the sale, not specified in the advertisement, may commonly be known at those offices; or by applying to the proprietor, or to his agent, previously to the day of sale.

3.—Building-ground is generally sold by auction; and if it be divided into small lots, it will tend much to promote the sale; as many persons may be desirous of purchasing a single house-stead, who would not find it convenient to purchase a lot containing two or three house-steads.

4.—The price of building-ground varies from sixpence to upwards of two guineas per square yard, according to the eligibility of the situation.

5.—The method of laying out building-ground so as to form straight streets at right-angles to each other, is exemplified in the Plan of a new Town, Plate VII. This town bears a considerable resemblance to Somers-town, and to Pentonville, near London.

SECTION III.

Miscellaneous Questions relating to Surveying, Laying-out, Parting-off, and Dividing Land.

1. The base of the largest Egyptian pyramid is a square, whose side is 693 feet; how many acres of ground does it cover? *Ans.* 11*a.* 0*r.* 4*p.*

2. Required the side of a square garden that cost 3*l.* 18*s.* 1½*d.* trenching, at 1½*d.* per square yard. *Ans.* 25 *yards.*

3. Required the area of a rectangle whose length is 1275, and breadth 675 links. *Ans.* 8*a.* 2*r.* 17*p.*

4. The area of a rectangular field is 14*a.* 2*r.* 11*p.*; what is its length, its breadth being 925 links? *Ans.* 1575 *links.*

5. A rectangular allotment upon a common, cost 78*l.* 1*s.* 10½*d.* digging and levelling, at 7*l.* 10*s.* per acre; what will be the expense of fencing it half round, at 5*s.* 6*d.* per rood; its length being 1225 links? *Ans.* 17*l.* 18*s.* 8*d.*

6. Measuring along the base of a field in the form of a rhomboides, I found the perpendicular to rise at 678, and its length 1264 links; the remainder of the base measured 2435 links; what is the area of the field? *Ans.* 39*a.* 1*r.* 15¾*p.*

7. A grass-plot, in a gentleman's pleasure-ground, cost 3*l.* 14*s.* 1*d.* making, at 4*d.* per square yard; what is the length of the base, the perpendicular being 40 feet, and the figure a rhombus? *Ans.* 50 *feet.*

8. What is the area of a triangular field, the base of which measures 3568 links, the perpendicular 1589 links, and the distance between one end of the base and the place of the perpendicular 1495 links? *Ans.* 28*a.* 1*r.* 15½*p.*

9. After measuring along the base of a triangle 895 links, I found the place of the perpendicular, and the perpendicular itself = 994 links; the whole base measured 1958 links; what is the area of the triangle? *Ans* 9*a.* 2*r.* 37*p.*

10. The area of a triangle is 6 acres, 2 roods, and 8 perches, and its perpendicular measures 826 links; what will be the expense of making a ditch, the whole length of its base, at 2*s.* 6*d.* per rood? *Ans.* 6*l.* 4*s.* 7$\frac{1}{4}$*d.*

11. What is the area of a triangle whose 3 sides measure 15, 20, and 25 chains respectively? *Ans.* 15 *acres.*

12. Required the area of a grass-plot in the form of an equilateral triangle, whose side is 36 feet. *Ans.* 561.18446 *feet.*

13. What is the area of a triangular field whose 3 sides measure 2564, 2345, and 2139 links? *Ans.* 23*a.* 2*r.* 0$\frac{1}{2}$*p.*

14. The 3 sides of a triangular fish-pond measure 293, 239, and 185 yards; what did the ground which it occupies cost, at 185*l.* per acre? *Ans.* 843*l.* 7*s.* 8*d.*

15. How many square yards of paving are there in a trapezium whose diagonal is found to measure 126 feet 3 inches, and perpendiculars 58 feet 6 inches, and 65 feet 9 inches? *Ans.* 871.47569 *yards.*

16. In taking the dimensions of a trapezium, I found the first perpendicular to rise at 568, and to measure 835 links; the second at 1865, and to measure 915 links; the whole diagonal measured 2543 links; what is the area of the trapezium? *Ans.* 22*a.* 1*r.* 0*p.*

17. Lay down a trapezium, and find its area from the following dimensions; namely, the side A B measures 345, B C 156, C D 323, D A 192, and the diagonal A C 438 feet. *Ans.* 52330.33406 *feet.*

18. What is the area of a trapezoid whose parallel sides measure 25 and 18 feet; and the perpendicular distance between them, 38 feet? *Ans.* 1197 *feet.*

19. The parallel sides of a piece of ground measure 856 and 684 links, and their perpendicular distance 985 links; what is its area? *Ans.* 7*a.* 2*r.* 13$\frac{1}{2}$*p.*

20. If the parallel sides of a garden be 65 feet 6 inches, and 49 feet 3 inches, and their perpendicular distance 56 feet 9 inches; what did it cost, at £325. 10*s.* per acre? *Ans.* 24*l.* 6*s.* 7$\frac{1}{4}$*d.*

21. It is required to lay down a pentangular field, and find its annual value at 2*l.* 5*s.* per acre, the first side measuring 926, the second 536, the third 835, the fourth 628, and the fifth 587 links; and the diagonal from the first angle to the third 1194, and that from the third to the fifth 1223 links.

Ans. 18*l.* 10*s.* 7½*d.*

22. The diameters of an elliptical piece of ground are 330 and 220 feet; how many quicks will plant the fence forming the circumference, supposing them to be set 5 inches asunder?

Ans. 2073.

23. Given the lengths of 7 equidistant ordinates of an irregular piece of ground, as follows; 15, 19, 20, 23, 25, 30, and 33 feet; and the length of the base 72 feet; required the plan and area. *Ans.* 1704 *feet.*

24. What must be the length of a chord which will strike the circumference of a circular plantation that shall contain just an acre and a half of ground? *Ans.* 48.072 *yards.*

25. The annual rent of a triangular field is 43*l.* 15*s.* its base measures 25, and perpendicular 14 chains; what is it let for per acre? *Ans.* 2*l.* 10*s.*

26. The transverse diameter of the ellipse in Grosvenor-square measures 840 links, and the conjugate 612, within the wall; the wall is 14 inches thick; what quantity of ground does it inclose, and how much does it occupy?

Ans. The wall incloses 4*a.* 0*r.* 6*p. and occupies* 1760.531 *square feet.*

27. Two sides of an obtuse-angled triangle are 5 and 10 chains; what must be the length of the third side, that the triangle may contain just 2 acres of ground?

Ans. 8.06225 *or* 13.60147 *chains.*

28. What is the area of an isosceles triangle inscribed in a circle whose diameter is 24; the angle included by the equal sides of the triangle being 30 degrees? *Ans.* 134.3538.

29. The side A B of a triangular field is 40, B C 30, and C A 25 chains; required the sides of a triangle parted off by

a division-fence made parallel to A B, and proceeding from a point in C A, at the distance of 9 chains from the angle A.

Ans. 16, 19.2, *and* 25.6 *chains.*

30. A field in the form of a right-angled triangle is to be divided between 2 persons, by a fence made from the right-angle, meeting the hypothenuse perpendicularly, at the distance of 880 links from one end; required the area of each person's share, the length of the division-fence being 660 links.

Ans. 2*a.* 3*r.* 24½*p. and* 1*a.* 2*r.* 21¼*p.*

31. It is required to part from a triangular field whose 3 sides measure 1200, 1000, and 800 links respectively, 1 acre, 2 roods, and 16 perches, by a line parallel to the longest side.

Ans. The sides of the remaining triangle are 927, 772½, *and* 618 *links respectively.*

32. The base of a field, in the form of a trapezoid, is 30, and the 2 perpendiculars are 28 and 16 chains respectively; it is required to divide it equally between 2 persons, by a fence parallel to the perpendiculars.

Ans. The division-fence is 22.8035 *chains, and it divides the base into two parts, whose lengths are* 17.0087 *and* 12.9913 *chains respectively.*

33. A gentleman a garden had,
Fivescore feet long and fourscore broad;
A walk of equal width half round
He made, that took up half the ground:
Ye skilful in geometry,
Tell us how wide the walk must be.

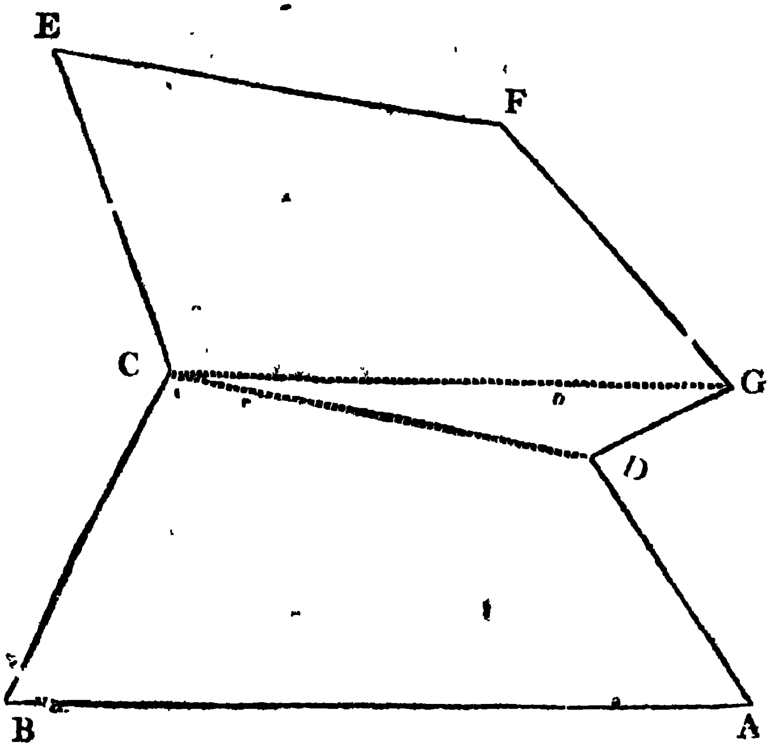
Ans. 25.96876 *feet.*

Note 1.—If the sum of the two diameters of an ellipse be multiplied by 1.5708, the product will be the circumference, exact enough for most practical purposes. (See Question 22.)

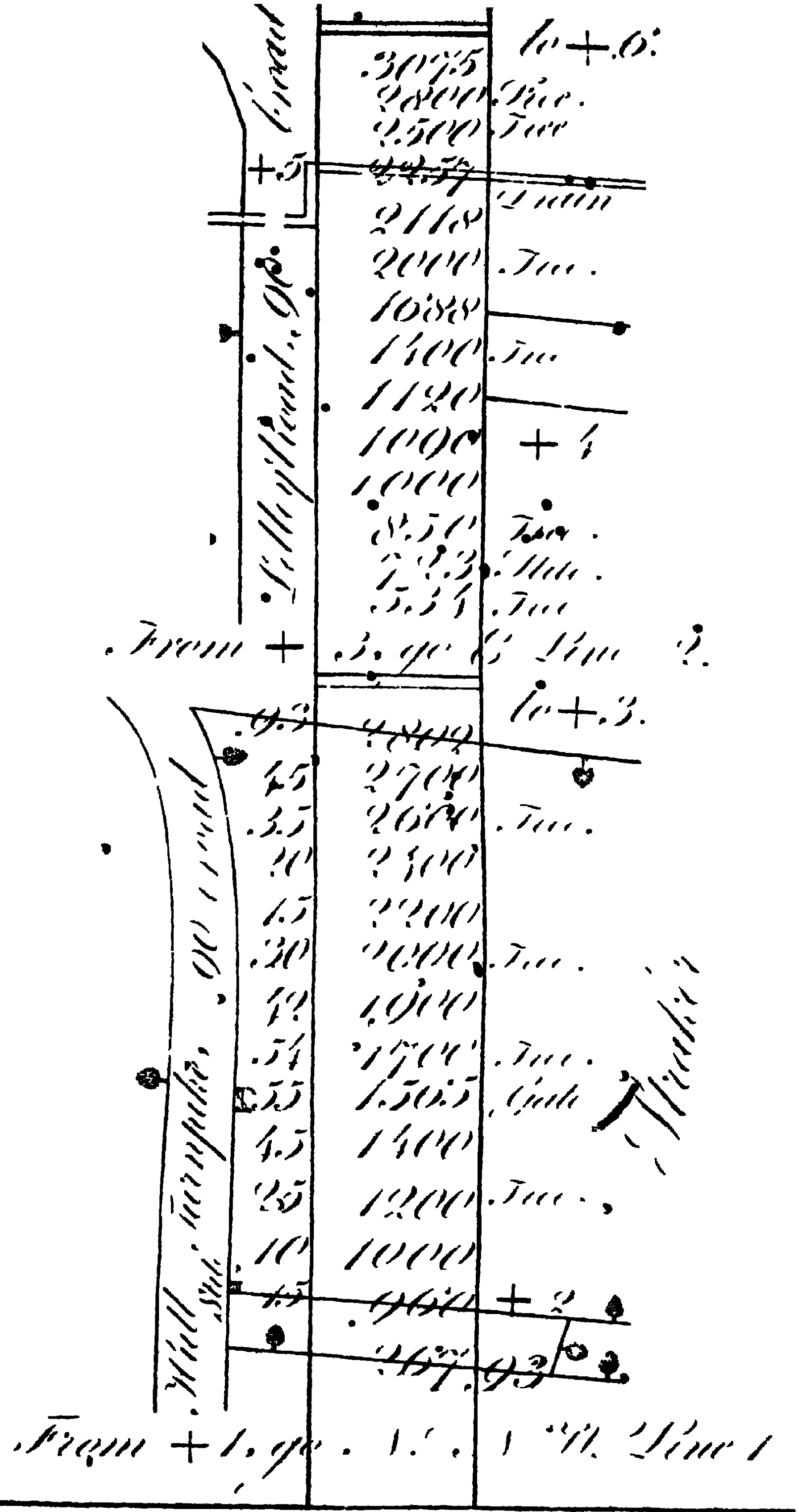
2.—All the foregoing Questions are taken from the Author's Treatise on Practical Mensuration; consequently, their Solutions may be found in the Key to that Work.

ADDENDA.

The following figure represents the chain-lines, forming the 2 trapeziums and the triangle, in Example 6, page 152.—When the learner constructs the figure, he must of course lay down the offsets, from the notes; and dot all the chain-lines, as before directed.

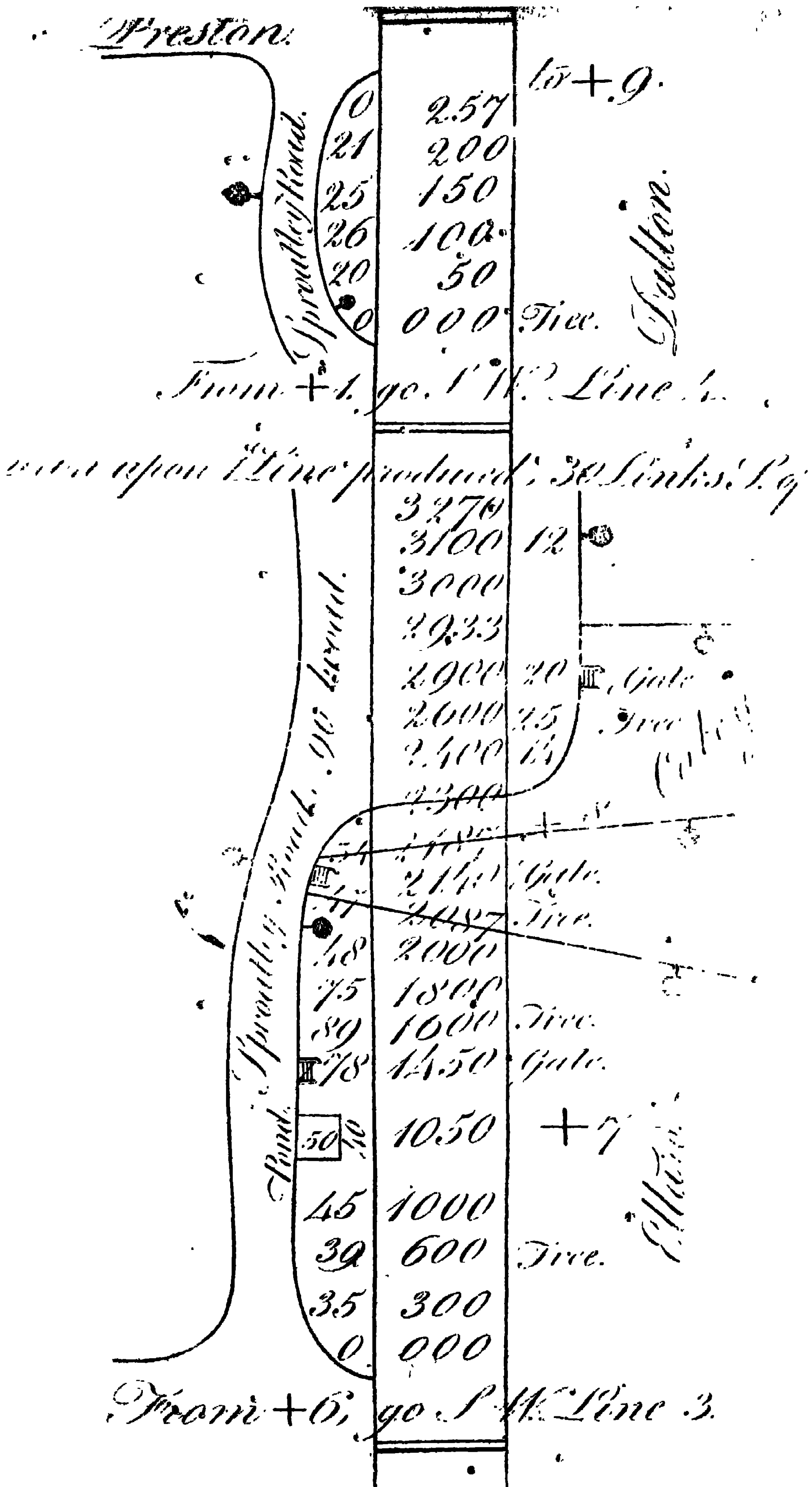


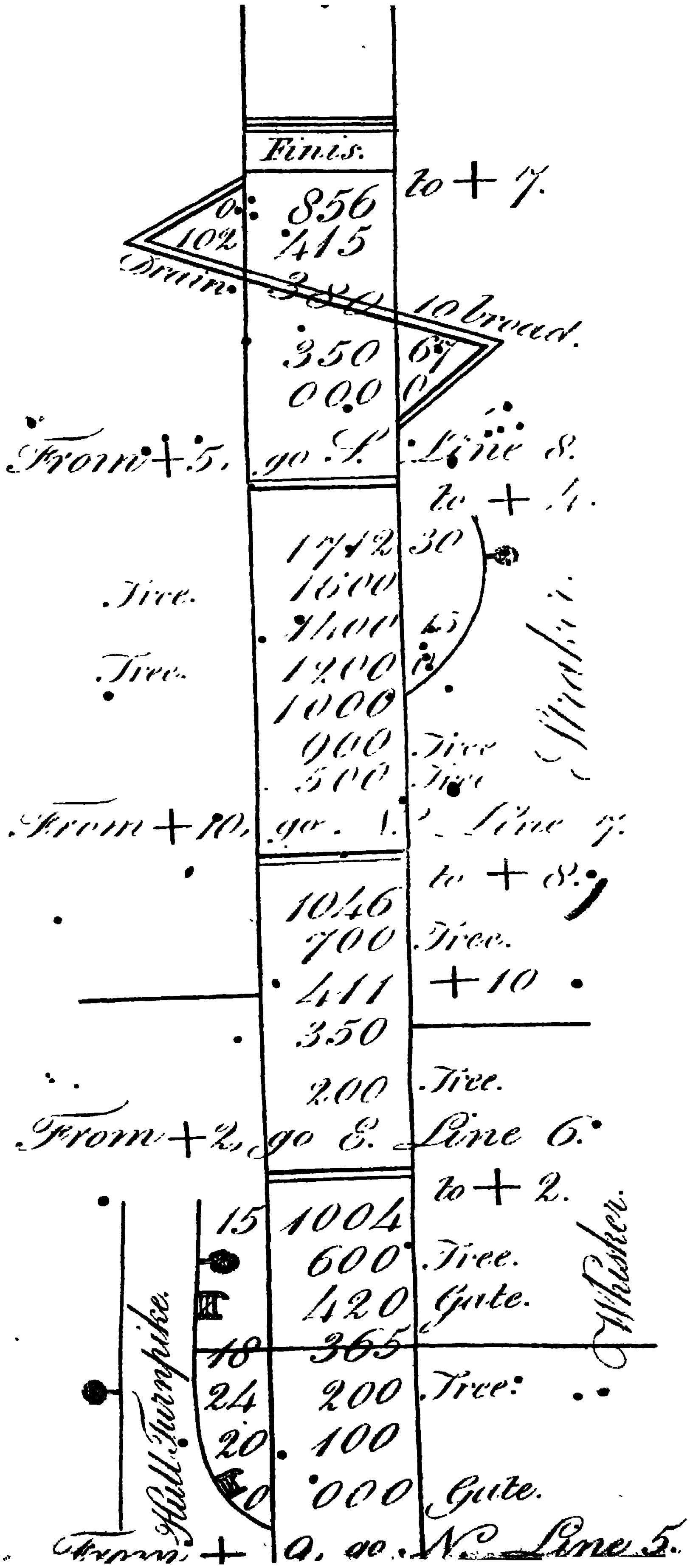
FINIS.

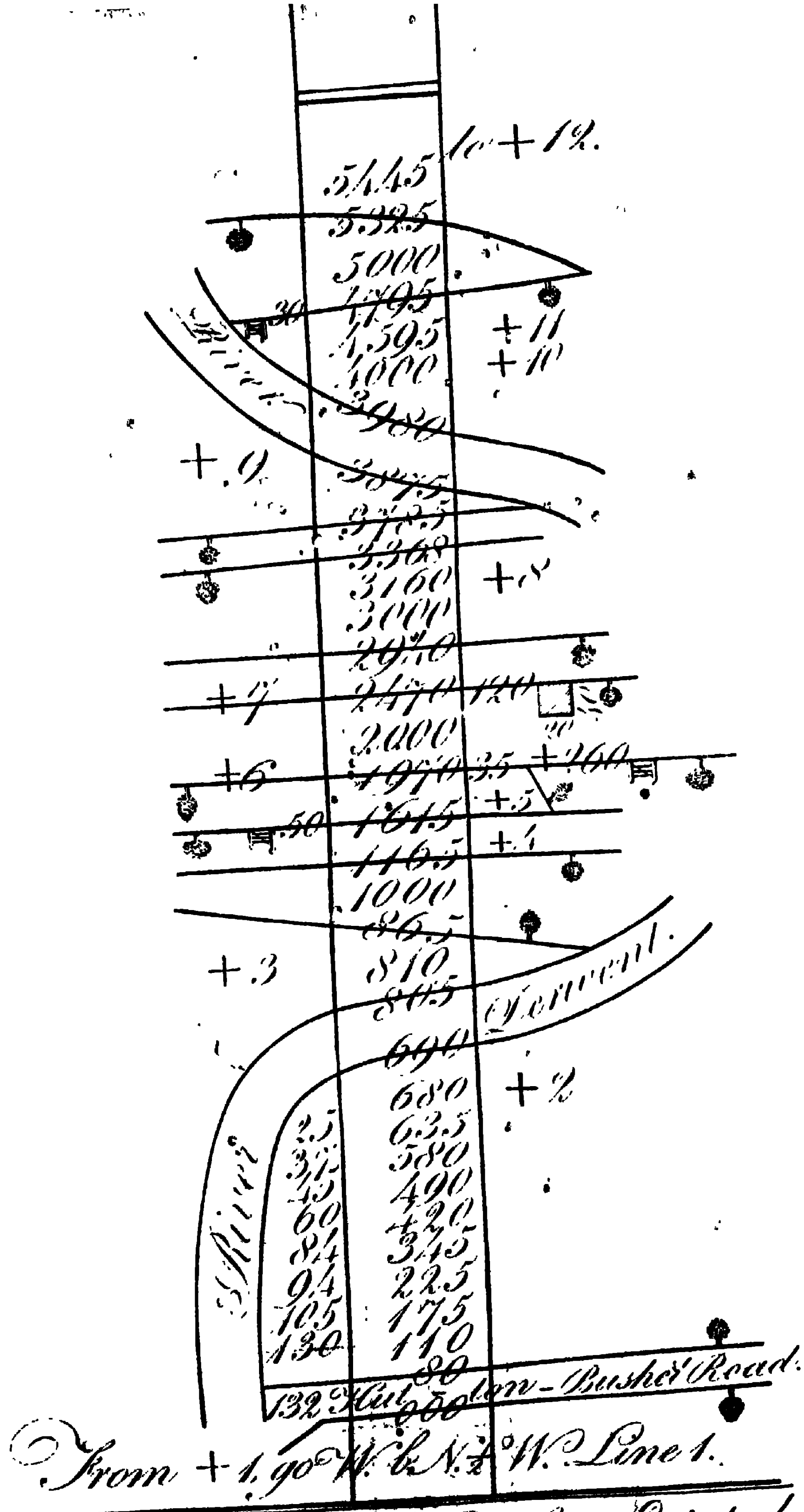


See Plate 8.— the Notes of an Estate
lying in the Parish of Preston in the
East-Riding of the County of York

FIELD-BOOK.

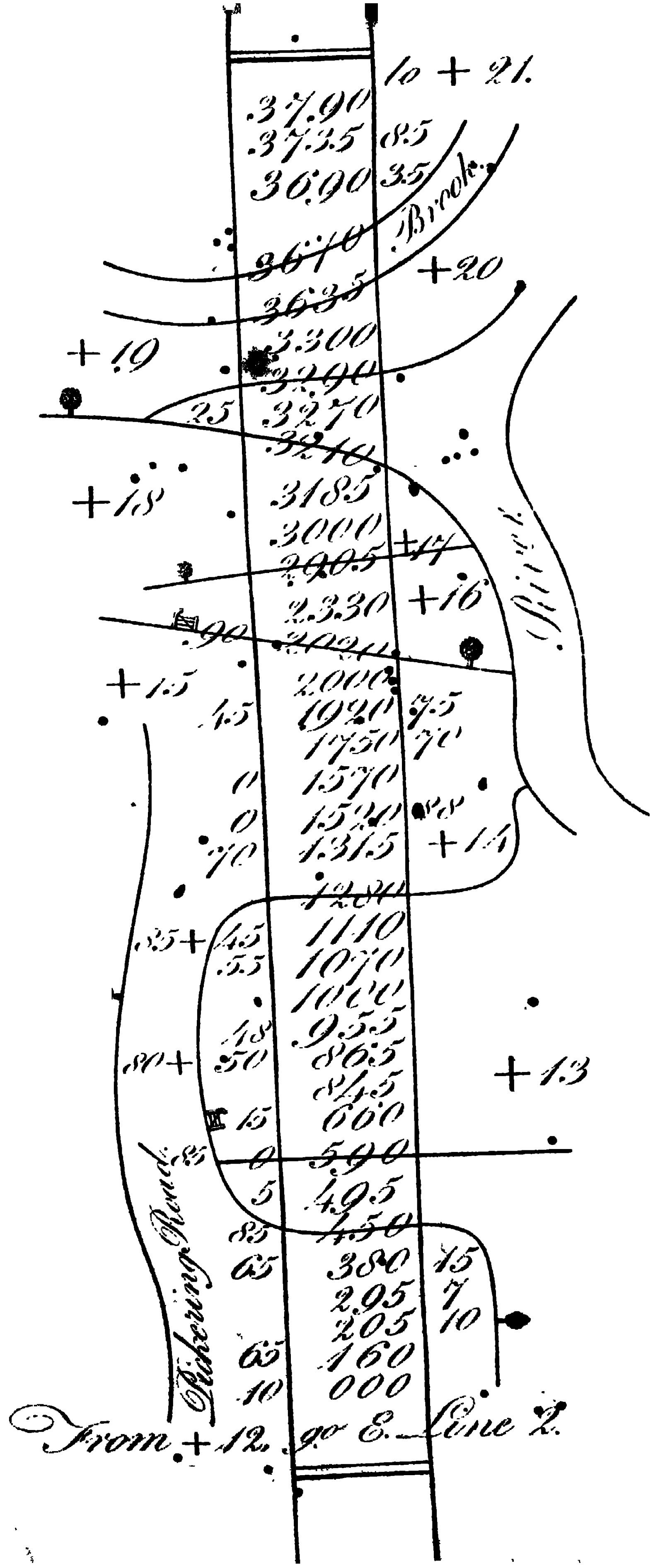

Preston.
15 +9.
0 257
21 200
25 150
26 100
20 50
0 000 Tree.
Sproutley Road.
Dalton.
From +1. go S W. Line 4.
even upon Line produced: 30 Links S.
3270
3100 12
3000
2933
2900 20 Gate.
2600 25 Tree
2400 13
2300
2160
2140 Gate.
2087 Tree.
48 2000
75 1800
89 1600 Tree.
78 1450 Gate.
50 10 1050 +7
45 1000
39 600 Tree.
35 300
0 000
Sproutley Road. 90 Links.
Road.
From +6. go S W. Line 3.

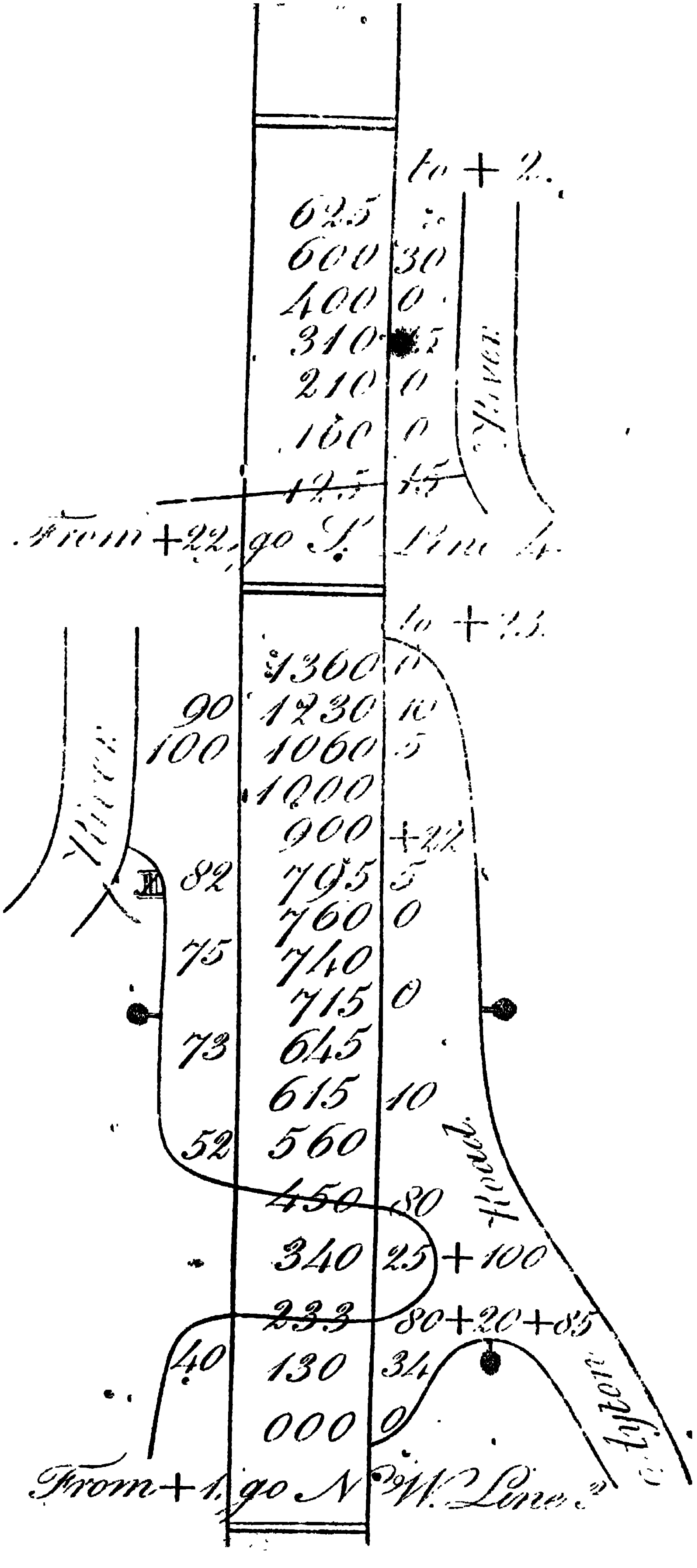

Finis.
to + 7.
0
102
856
415
Drain.
380
10 broad.
350
67
000
0
From + 5. go S. Line 8.
to + 4.
1712
30
Tree.
1600
1400
45
Tree.
1200
0
1000
900
Tree.
500
Tree.
Shaker.
From + 10. go N. Line 7.
to + 8.
1046
700
Tree.
411
+ 10
350
200
Tree.
From + 2. go E. Line 6.
to + 2.
15
1004
600
Tree.
420
Gate.
18
365
24
200
Tree.
20
100
0
000
Gate.
Hull Turnpike.
Whisker.
From + 0. go N. Line 5.



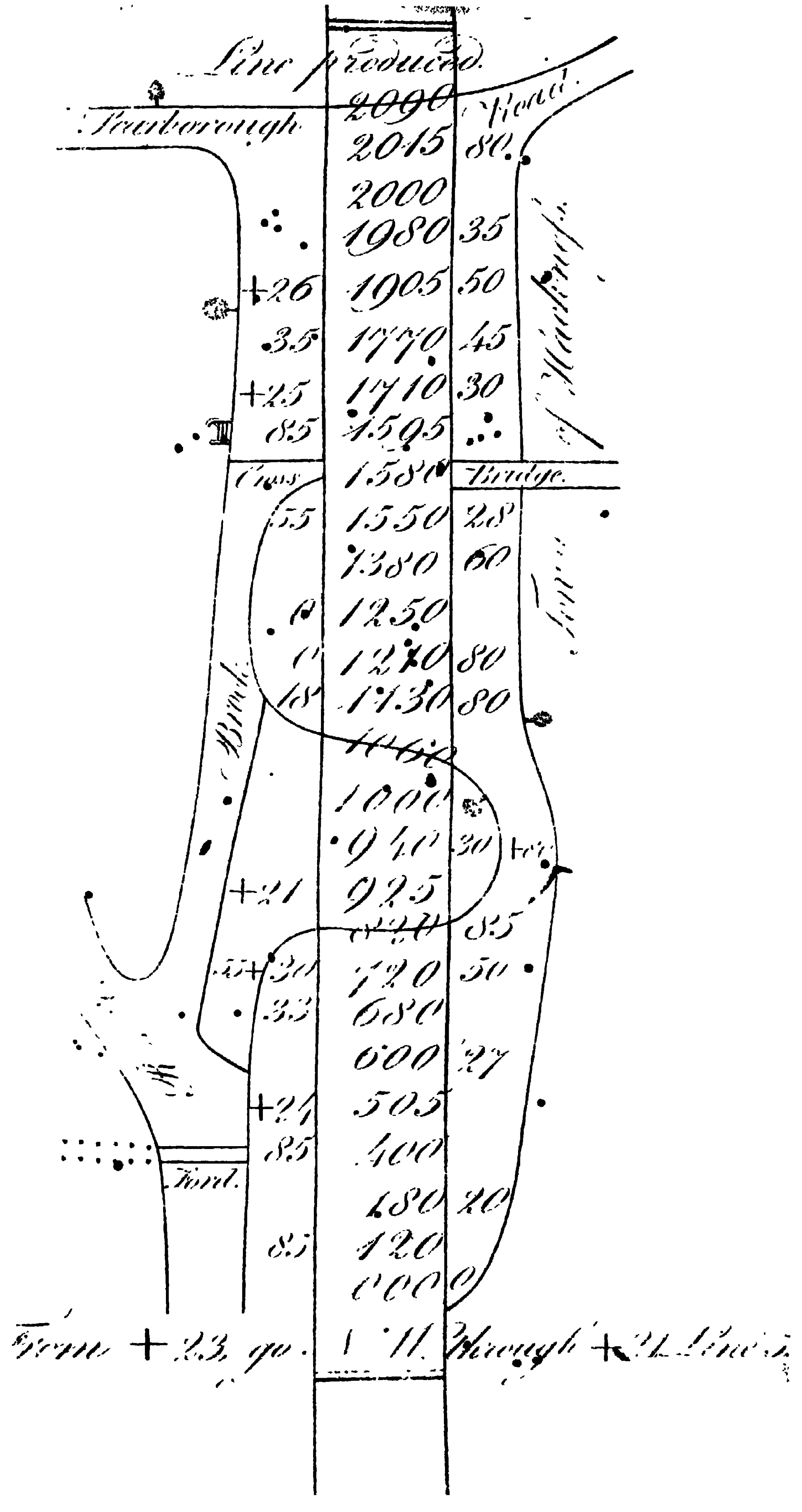
See Plate 10. – The Notes of an Estate lying in the Parishes of Hackness and Hutton-Bushel, in the North Riding of the County of York.

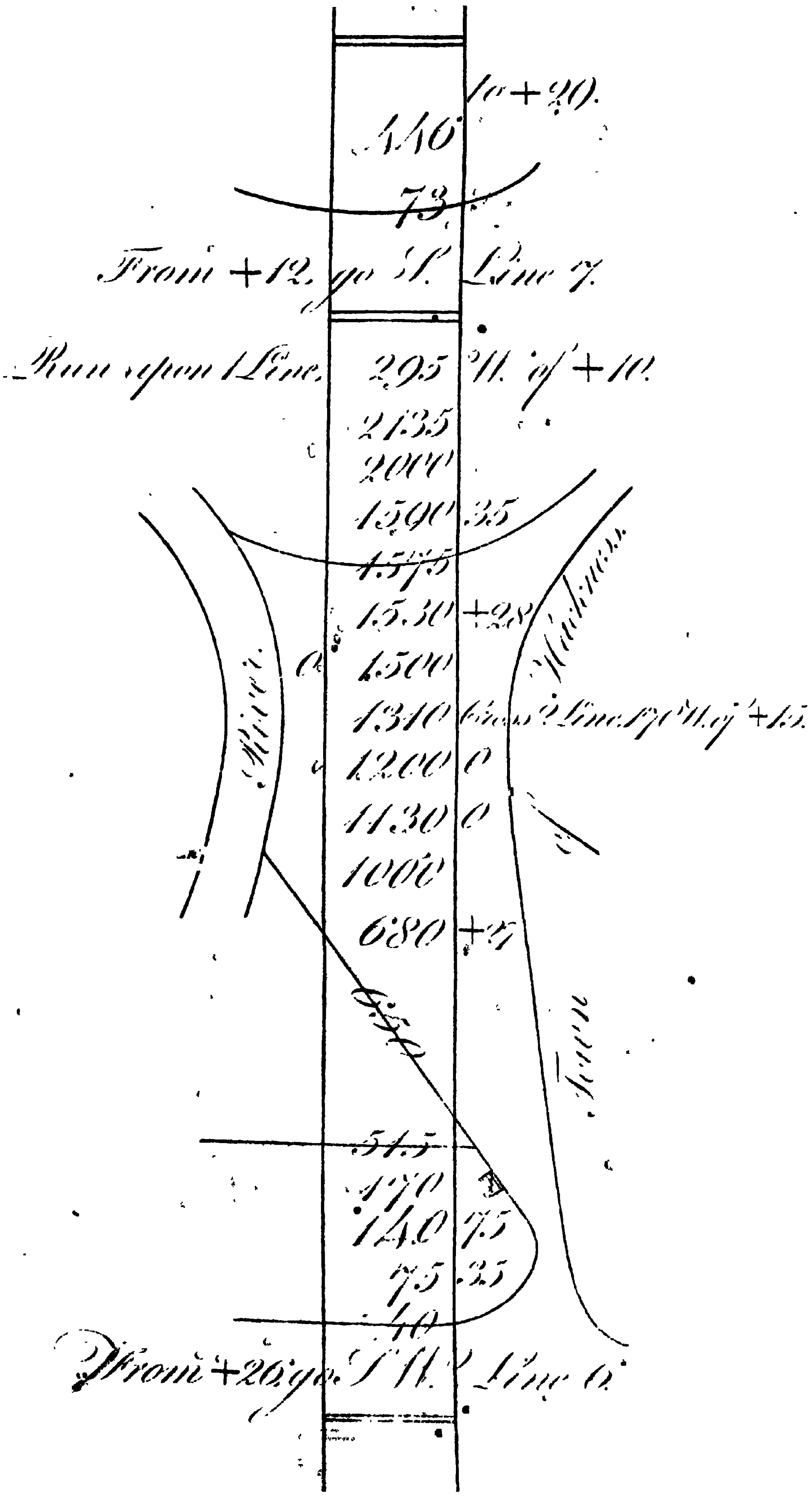
FIELD-BOOK.

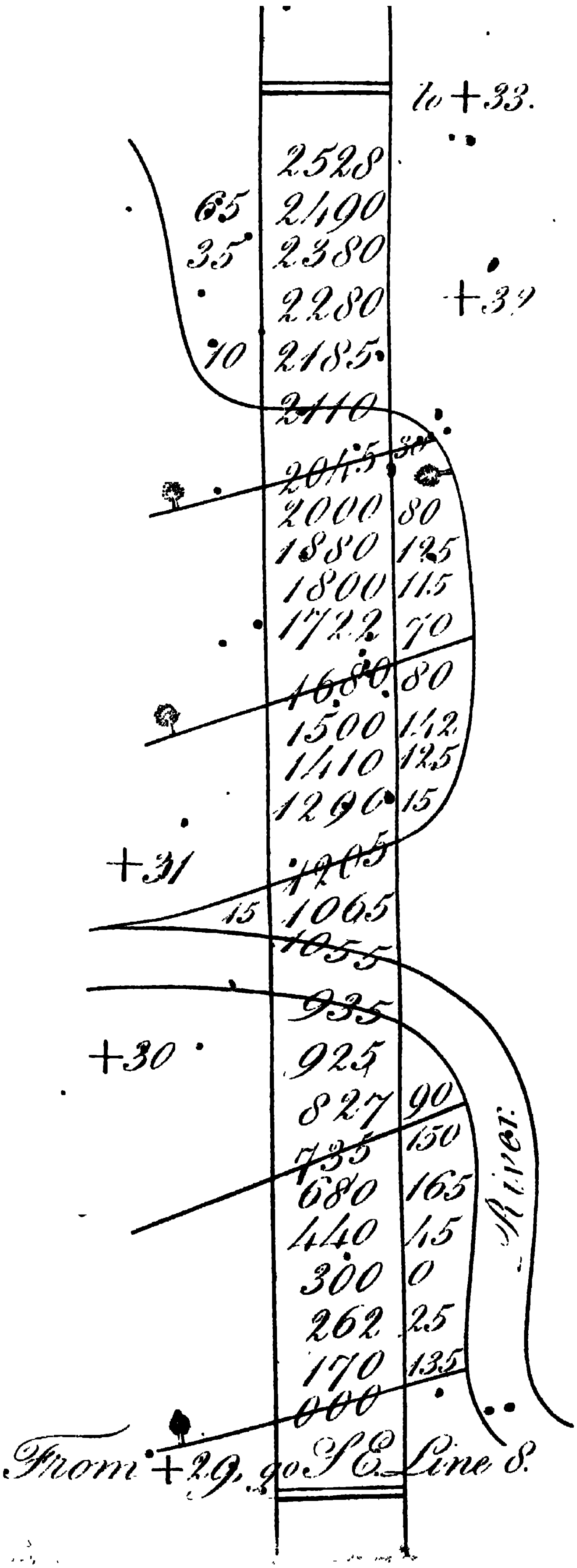

to + 21.
37.90
37.35
85
36.90
35
Brook.
36.70
36.35
+ 20
33.00
+ 19
32.90
25
32.70
32.10
31.85
+ 18
30.00
+ 17
29.05
23.30
+ 16
River.
.90
20.20
+ 15
20.00
45
19.20
75
17.50
70
0
15.70
0
15.20
88
70
13.15
+ 14
12.00
35 +
45
11.10
55
10.70
10.00
48
9.55
80 +
50
8.65
8.45
+ 13
15
6.00
85
0
5.00
5
4.95
85
4.50
65
3.80
75
2.95
7
2.05
10
Pickering Road.
65
1.60
10
000
From + 12. go E. Line 2.



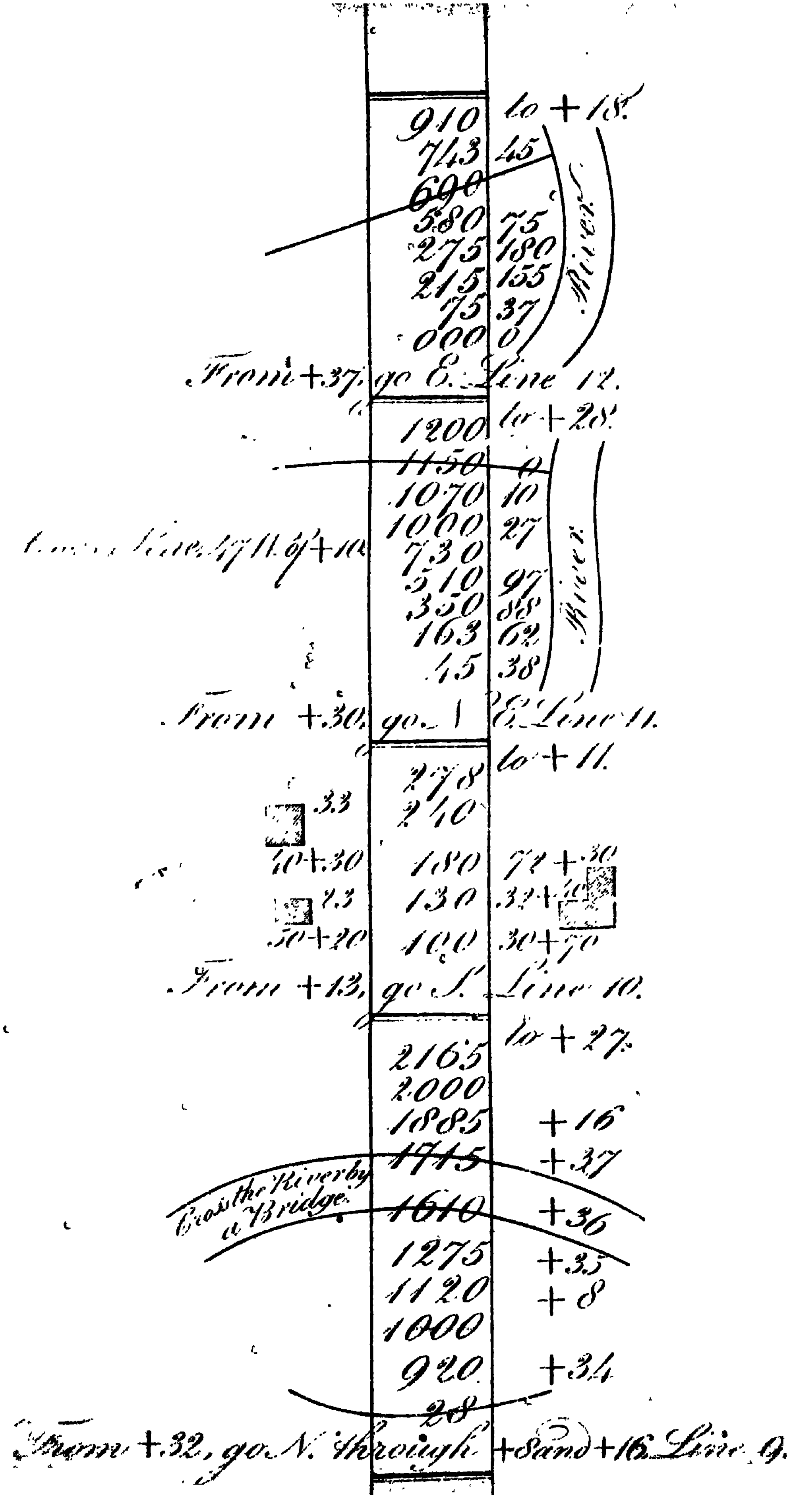
to + 2.
625
600 30
400 0
310 15
210 0
160 0
125 15
River.
From + 22, go S. Line 4.
to + 23.
1360 0
90 1230 10
100 1060 5
1000
900 +22
River.
82 795 5
75 760 0
740
715 0
73 645
615 10
52 560
450 80
Road.
340 25 +100
233 80 +20 +85
40 130 34
000 0
Lytton
From + 1, go N. W. Line 3.

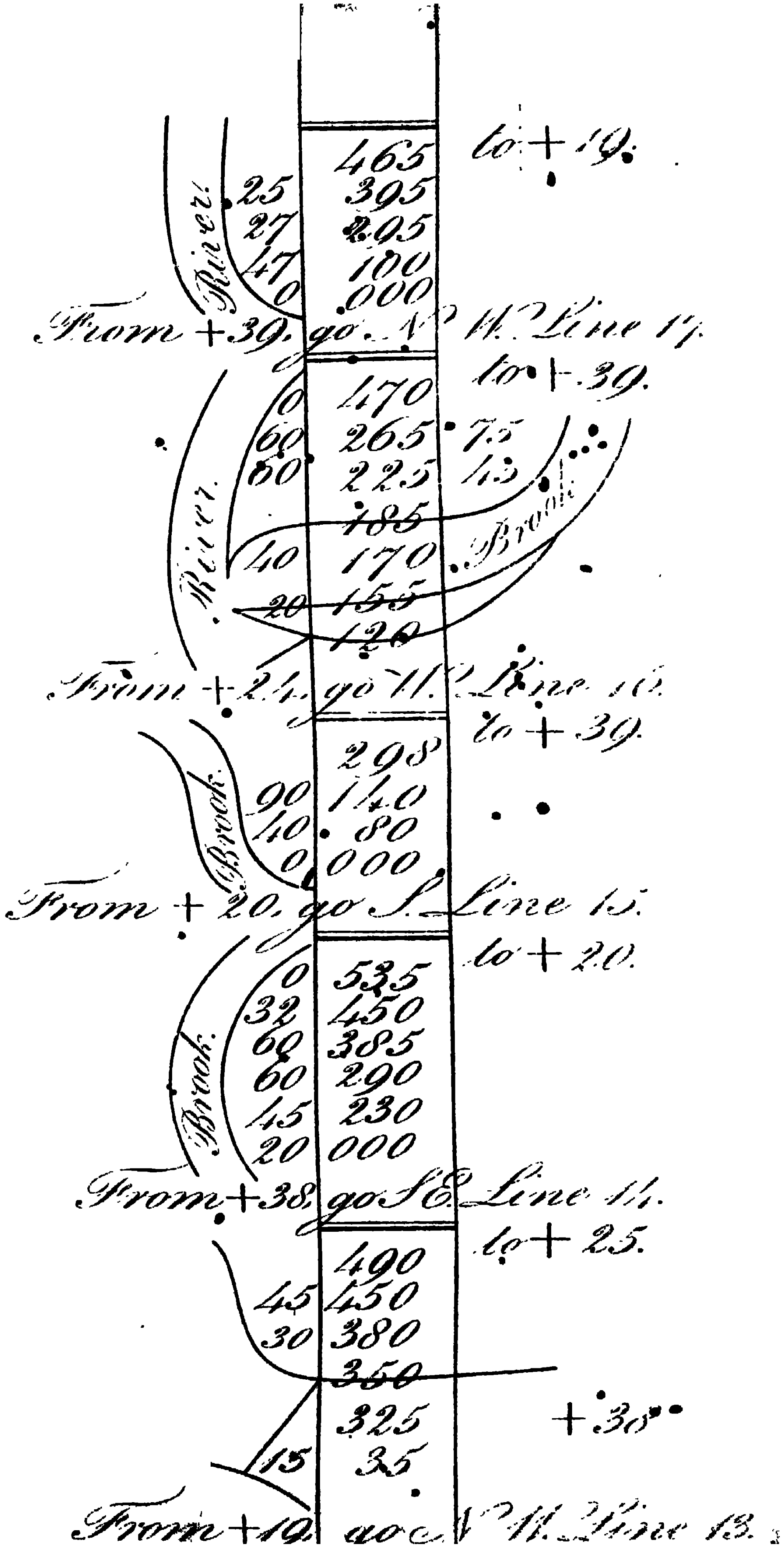

Line produced.
Peterborough Road
~~2000~~
2015 80.
2000
1980 35
+26 1905 50
35 1770 45
+25 1710 30
85 1595
Cross 1580 Bridge.
55 1550 28
1380 60
0 1250
0 1210 80
18 1130 80
1060
Brook
1000
940 30
+21 925
820 85
.55 +30 720 50
33 680
600 27
+24 505
85 400
Ford.
180 20
85 120
000
Lane
From + 23 go. 1° W. through + 24 Line 1.


to + 20.
110
73
From +12. go S. Line 7.
Run upon 1 Line. 295 N. of +10.
2135
2000
1590 .35
1575
1530 +28
1500
1310 Cross Line 17 N. of +15.
1200 0
1130 0
1000
680 +4
650
545
470
140 75
75 .25
40
From +20 go S. W. Line 6.
River
Ck
Hickman
Town

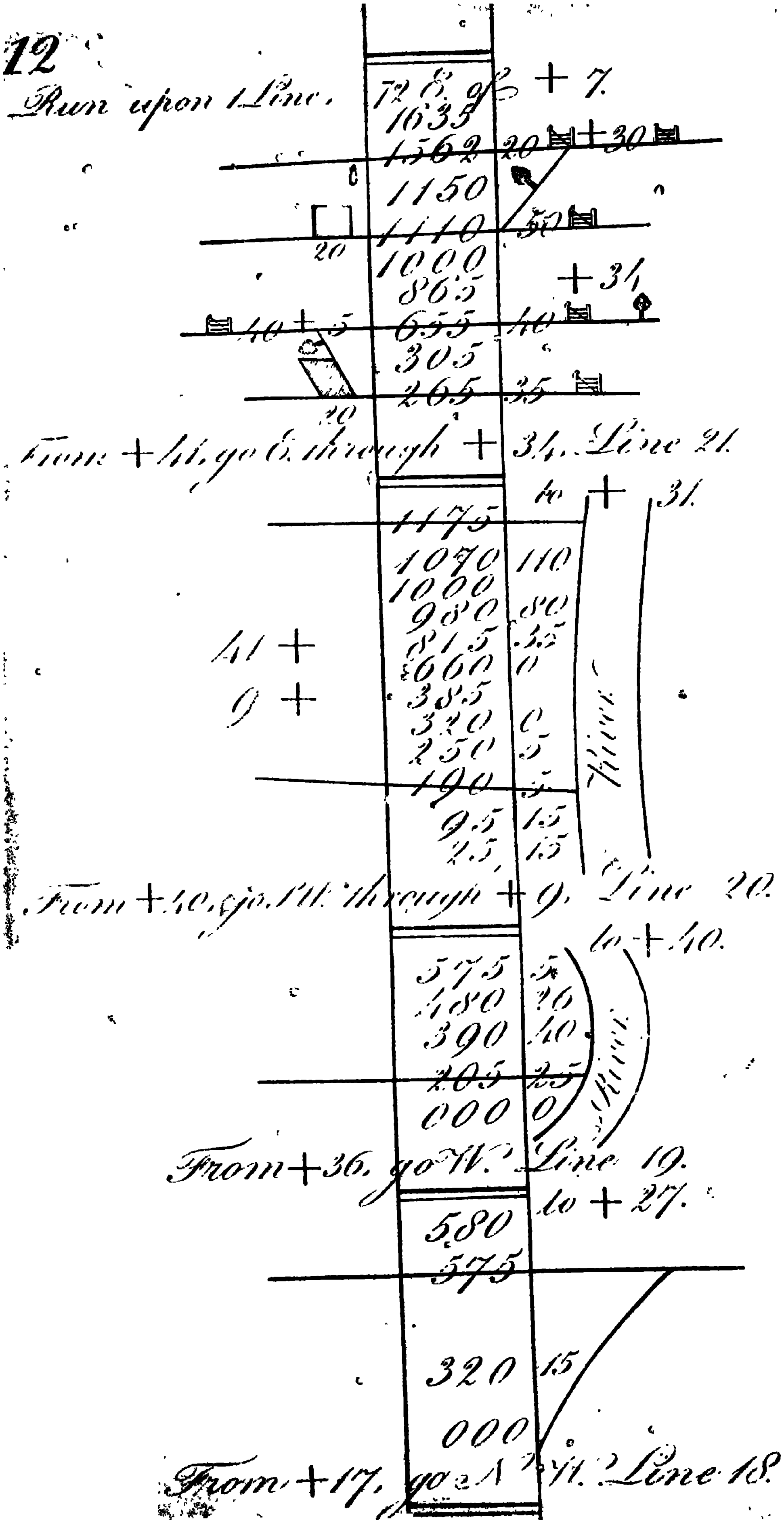


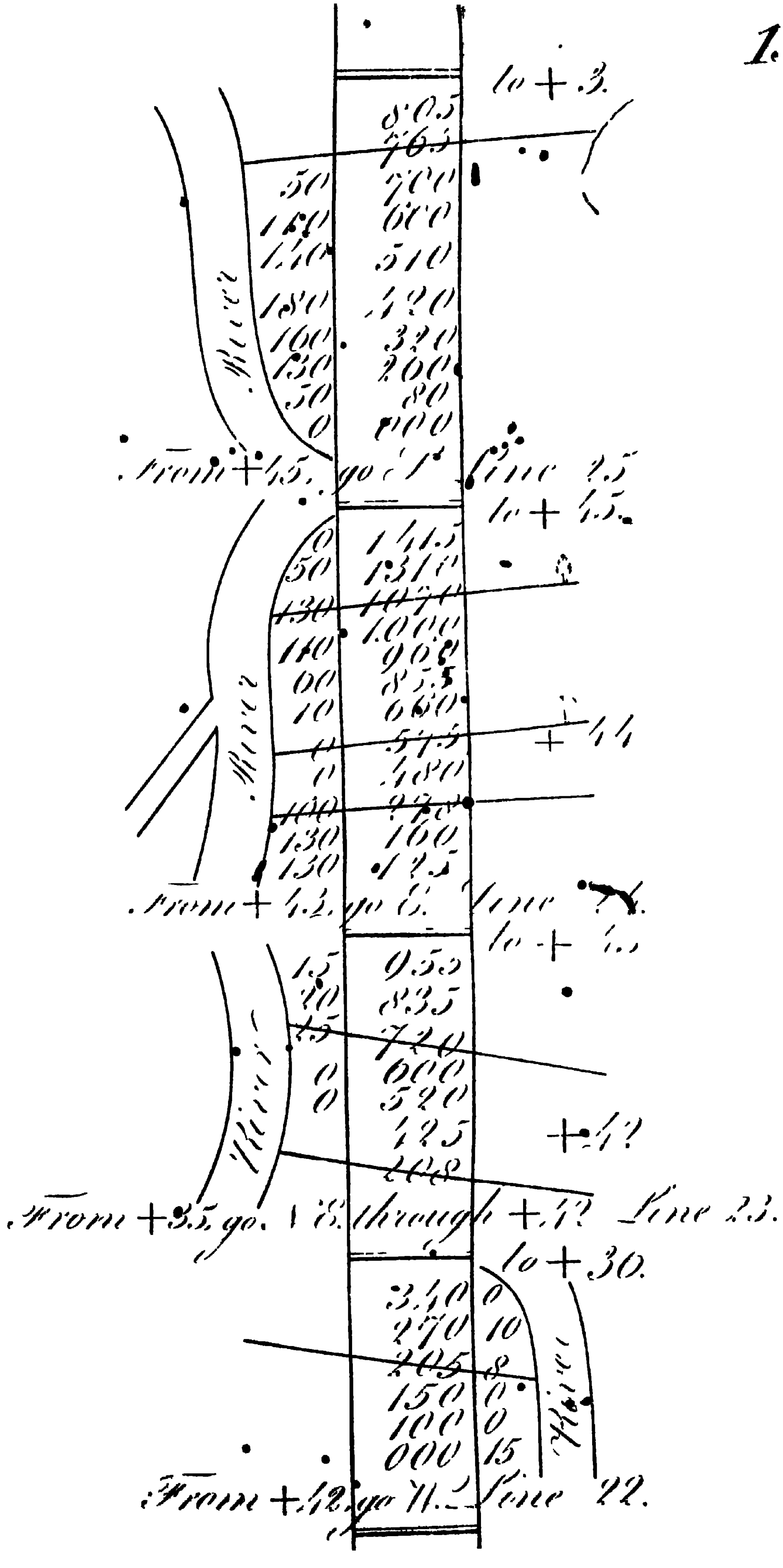
From +29. go S E Line 8.

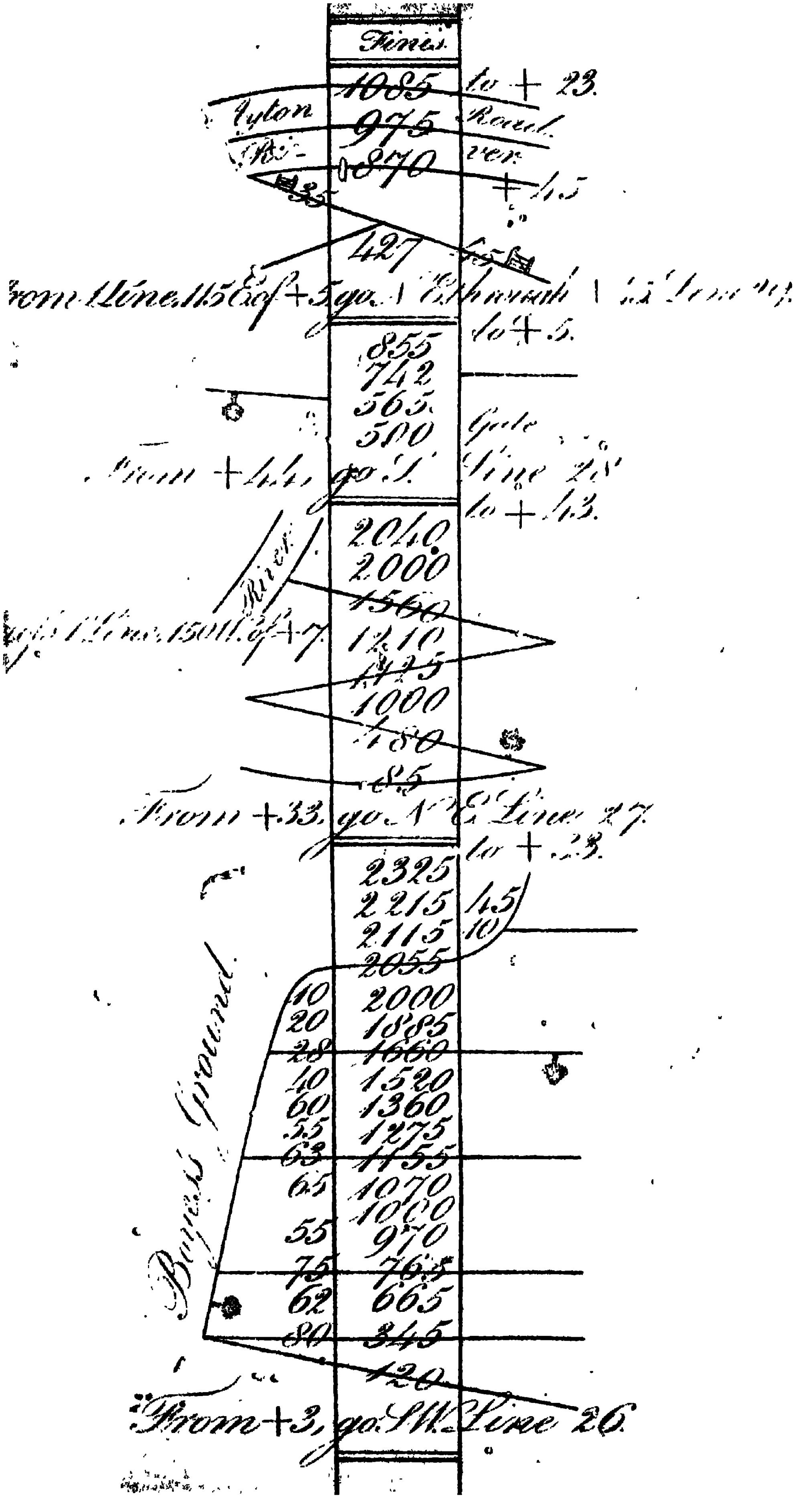

to +18.
910
743 45
690
580 75
275 180
215 155
75 37
000 0
River
From +37. go E. Line 12.
to +28.
1200
1150 0
1070 10
1000 27
Cross Line 4711. of +10
730
510 97
350 88
163 62
45 38
River
From +30. go N E. Line 11.
to +11.
278
240
33
40+30
180
72+30
23
130
32+40
50+20
100
30+70
From +13. go S. Line 10.
to +27.
2165
2000
1885 +16
1715 +37
Cross the River by a Bridge
1610 +36
1275 +35
1120 +8
1000
920 +34
28
From +32, go N. through +Sand+16. Line 9.

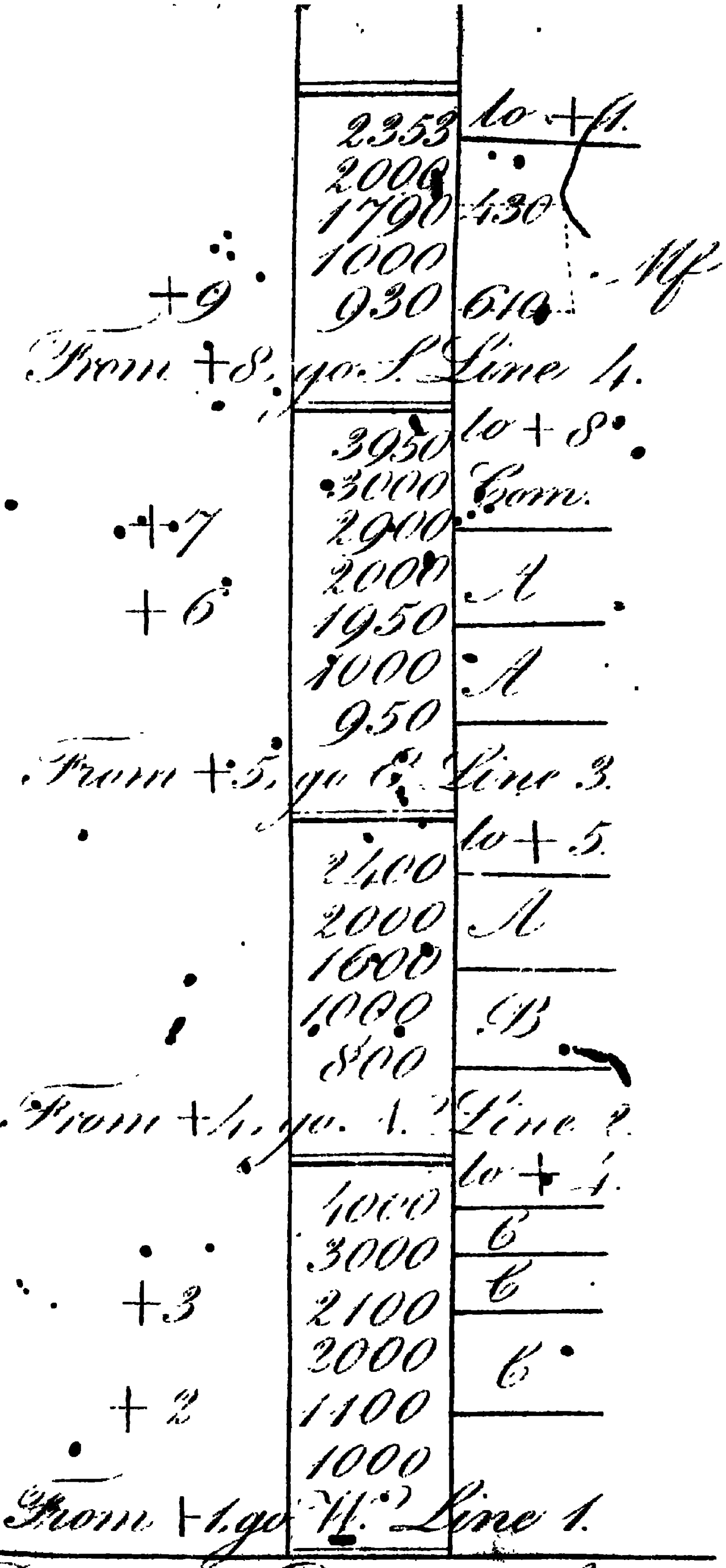

to +19.
465
25 395
27 205
47 100
0 000
River.
From +39. go N.W. Line 17.
to +39.
0 470
60 265 75
60 225 45
185
40 170
20 155
120
River.
Brook.
From +24. go N.W. Line 16.
to +39.
298
90 140
40 80
0 000
Brook.
From +20. go S. Line 15.
to +20.
0 535
32 450
60 385
60 290
45 230
20 000
Brook.
From +38. go S.E. Line 14.
to +25.
490
45 450
30 380
350
325 +30
15 35
From +19. go N.W. Line 13.

12


Run upon 1 Line.
72 E. 9 + 7.
1635
1562 20 + 30
1150
20 1110 50
1000
865 + 34
40 + 5 655 40
305
20 265 35
From + 41, go E. through + 34. Line 21.
to + 31.
1175
1070 110
1000
980 80
41 + 815 35
660 0
9 + 385
320 0
250 5
190 5
95 15
25 15
River
From + 40, go N.W. through + 9. Line 20.
to + 40.
575 5
480 26
390 40
205 25
000 0
River
From + 36. go W. Line 19.
to + 27.
580
575
320 15
000
From + 17. go N. W. Line 18.


to + 3.
805
763
50 700
150 600
140 510
180 420
160 320
130 200
50 80
0 000
River
From + 45. go S. Line 25
to + 45.
0 1445
50 1310
130 1070
110 1000
00 905
10 855
0 660
0 575
0 480
100 325
130 160
130 125
River
+ 44
From + 42. go E. Line 24.
to + 45.
15 955
10 835
15 720
0 600
0 520
425
208
River
+ 42
From + 35. go N. E. through + 42. Line 23.
to + 30.
340 0
270 10
205 8
150 0
100 0
000 15
River
From + 42. go W. Line 22.


Finis
1085 to + 23.
Ayton Road.
River
+ 45
From 1 Line 115 E of + 5, go N E Line
to + 5.
Gate
From + 44, go S. Line 28
to + 43.
River
2040
2000
1500
Line 150 W of + 7.
From + 33, go N E Line 27
to + 23.
2055
2000
1885
1660
1520
Bayn's Ground
From + 3, go S W. Line 26.



2353 to +1.
2000
1790 430
1000 Mf
+9 930 610
From +8, go S. Line 4.
3950 to +8.
3000 Com.
+7 2900
2000 A
+6 1950
1000 A
950
From +5, go E. Line 3.
2400 to +5.
2000 A
1600
1000 B
800
From +4, go N. Line 2.
4000 to +4.
3000 C
+3 2100 C
2000 C
+2 1100
1000
From +1, go W. Line 1.

See Plate 12.–The Notes of three small Estates and a Common, belonging to three Gentlemen, A. B. and C.

FIELD-BOOK.

FINIS.

Ms denote the quantity line measured (.) that side of the ditch on which the fence stands.

Links

to + 1

1765

1000

M 1000

778

From + 9 go S.W. Diag Line 8

to + 6

3048

2060

2000 B

1576

1013

1000

From + 4 go N.E. Diag Line 7

to + 3

3104

3000

2110

1000

1590

1265

M 1000

From + 8 go S.W. Diag Line 6

to + 7

2300

2000 Com

1598 M

1583

B 1000

748 M

535

From + 2 go N. Line 5.

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